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By Terrell Croft

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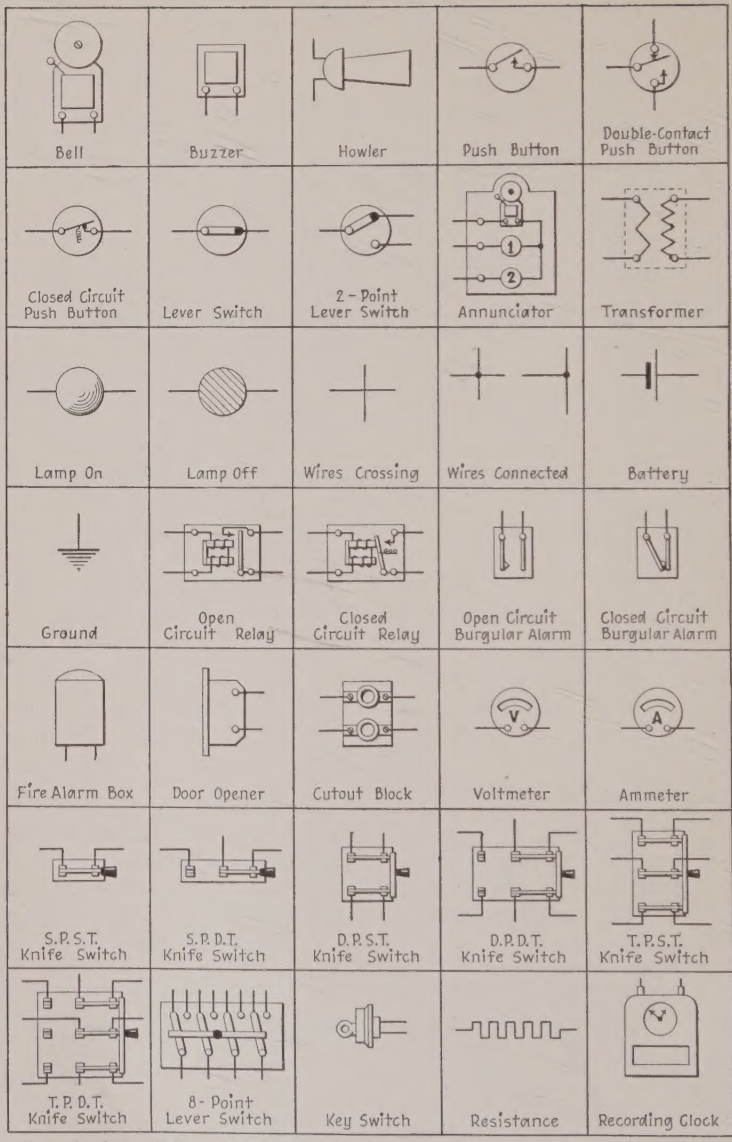

Frontispiece—The principal signal-wiring symbols which have been used in this book.

SIGNAL WIRING

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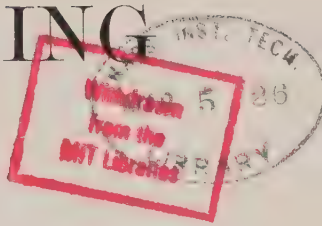

BY

TERRELL CROFT

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MEMBER OF THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
MEMBER OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
MEMBER OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
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PREFACE

Signal Wiring is, from the standpoint of the man who installs it (herein no attempt has been made to treat the design or manufacture of the devices themselves) largely a matter of knowledge of the circuits. The currents involved are small. The voltages are, usually, very low. The conductors must, generally, be much larger—to afford sufficient mechanical strength—than the purely electrical characteristics of the circuit would make necessary. The National Electrical Code rules, which govern the installation of these low-voltage signal circuits, are few, liberal and readily remembered. (They are reproduced in Div. 16.)

Hence, the information which is ordinarilly desired is: how to connect the apparatus—what the circuits are. So this book is, principally, one of circuit diagrams—over 460 diagrams. The closing division on "Methods" contains necessarilly, considerable text; but even here the endeavor has been made to tell most of the story with pictures.

The "Contents" lists the various division titles and many of the topics which have been treated; there would be no gain in repeating them here. Those diagrams which have been reproduced have been selected from a mass of available material as being those most useful to the average man.

With this, as with the other books which have been prepared by the author, it is the sincere desire to render it of maximum usefulness to the readers. It is the intention to improve the book each time it is revised and to enlarge it as conditions may demand. If these aims are to be satisfied most effectively, it is essential that the readers cooperate. This they may do by advising the author of alterations which would be desirable. Future revisions and additions will, insofar as is practicable, be based on these suggestions and corrections from readers.

Although the proofs have been read and checked very carefully by several competent persons, it is possible that some

145894

undiscovered errors remain. Readers will confer a decided favor in advising the author of any such.

TERRELL CROFT.

ST. LOUIS, MISSOURI,
September, 1925.

ACKNOWLEDGMENTS

The author desires to acknowledge the assistance which has been rendered by a number of concerns and individuals in the preparation of this book. Among the concerns which cooperated in supplying material for illustrations are:

Western Electric Co.
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Technical periodicals permitted the reproduction of certain material which first appeared in their pages. Some of the magazines which thus permitted use of their matter are:

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Popular Electricity & Modern Mechanics.
National Engineer.

Coal Age.
Modern Mechanics.
Electrical Review & Industrial Engineer.
Electrical World.
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Journal of Electricity & Western Industry.
Science and Invention.
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Engineering News Record.
Mining & Metallurgy.
Engineering & Mining Journal.
Everyday Engineering.
Electric Railway Journal.

Other acknowledgments appear throughout the book. If any has been omitted, it is due to oversight and will, if brought to the author's attention, be incorporated in a future edition.

Special acknowledgment is hereby accorded to Daniel Staehle, Jr., *Electrical Engineer* with *The Terrell Croft Engineering Company*, who has been largely responsible for the production of the book and who has assisted in every possible way since its inception.

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DIVISION 1

BELLS AND ANNUNCIATORS

SIGNAL WIRING

DIVISION 1

BELLS AND ANNUNCIATORS

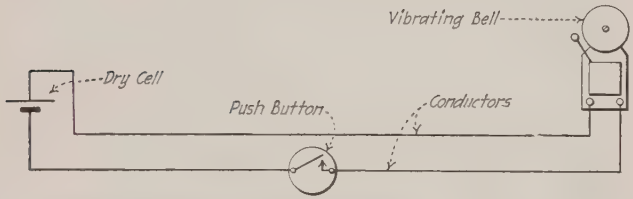


FIG. 1.—A simple electric bell circuit consisting of a bell, a dry cell and a single-contact button.

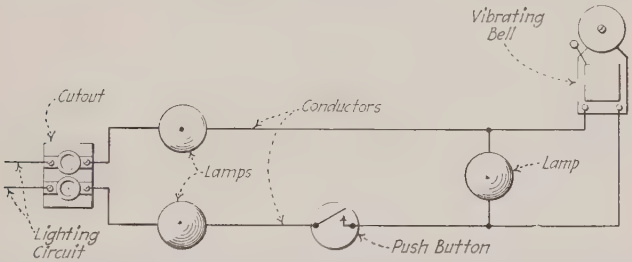


FIG. 2.—A method of operating bells from a direct-current lighting circuit. Incandescent lamps are used for resistance, one lamp being placed in each leg and one shunted around the bell. This system is not permitted in some cities and is contrary to the provisions of the *National Electrical Code*.

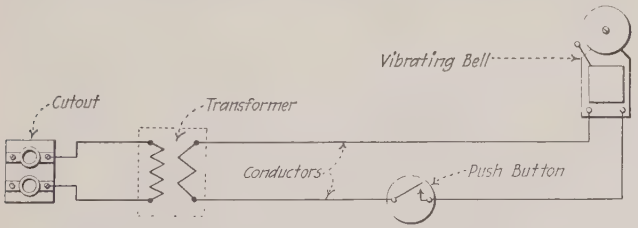


FIG. 3.—Method of operating a bell circuit from a bell-ringing transformer. Care must be taken not to reverse the primary and secondary sides of the transformer.

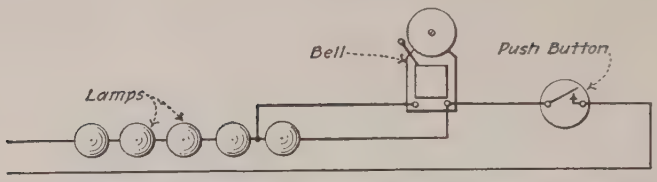


Fig. 4.—Three-wire bell circuit operated from direct-current light circuit. The resistance lamp, which is connected in multiple with the bell, tends to minimize damage, due to arcing, to the bell contacts. This arrangement is contrary to the provisions of the *National Electrical Code.*

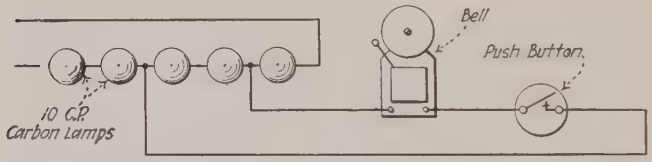


Fig. 5.—Bell circuit operated from direct-current light circuit. (This arrangement is contrary to the provisions of the *National Electrical Code.*)

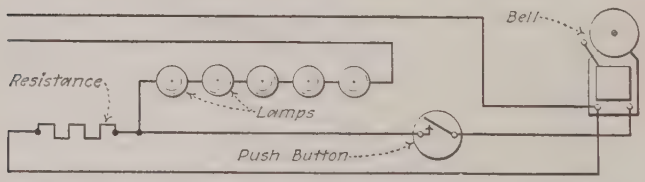


Fig. 6.—Bell circuit operated from a 500-volt direct-current power circuit. The resistance in multiple with the bell tends to minimize damage to the bell-vibrator contact points due to arcing. This arrangement is contrary to the provisions of the *National Electrical Code.*

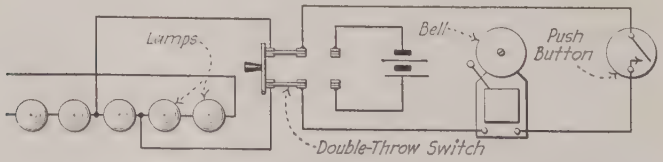


Fig. 7.—Bell circuit operated from direct-current light circuit with emergency throw-over switch to battery. (This arrangement is contrary to the provisions of the *National Electrical Code.*)

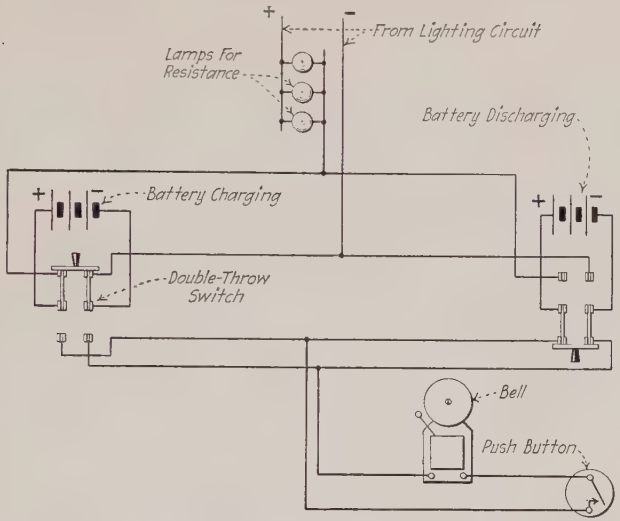


FIG. 8.—Bell circuit using two storage batteries. One of the batteries is charging while the other is in service.

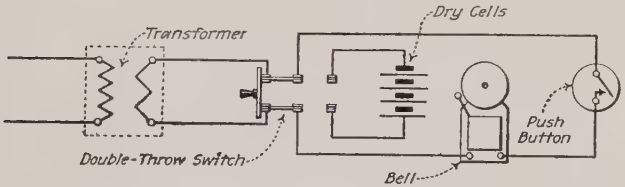


FIG. 9.—Bell circuit operated from alternating-current light circuit with emergency throw-over switch to battery. This arrangement satisfies the provisions of the *National Electrical Code.*

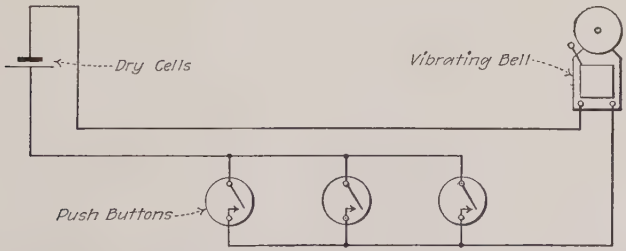


FIG. 10.—Diagram illustrating the connection of a bell operated by three single-contact buttons.

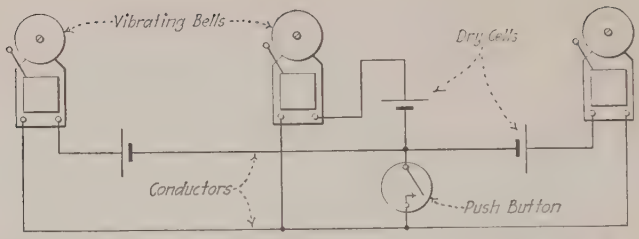


Fig. 11.—Wiring diagram for the positive operation of three bells from a single-contact button. A separate source of current is provided for each bell. Correct observance must be given to polarity, otherwise all three bells will ring should one of the batteries be connected reversed. With the arrangement which is shown, should any one of the bells get out of order the other two bells will continue to function undisturbed.

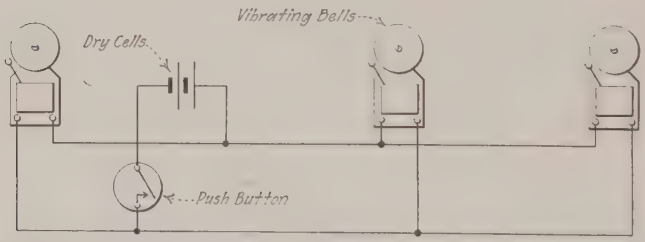


Fig. 12.—Operating three bells in parallel from one source of current and controlled by one single-contact push button.

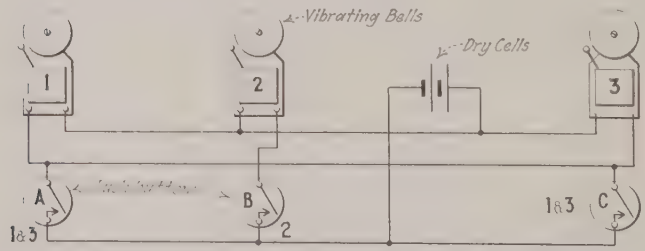


Fig. 13.—Three bells, three-push buttons, and one current source so connected that button "*A*" operates bells 1 and 3, button "*B*" operates bell 2, and button "*C*" operates bells 1 and 3.

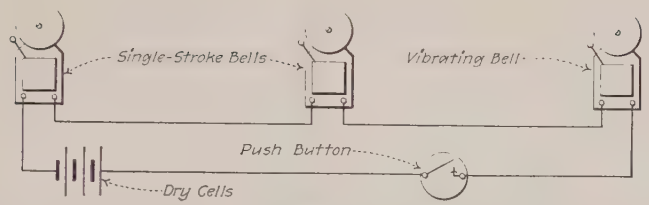


FIG. 14.—Three bells operated from one current source and controlled from one push button. The three bells are connected in series, one bell is of the vibrating type and the other two of the single stroke type. The disadvantage of this type of circuit is, should one bell get out of order, the entire system is interrupted.

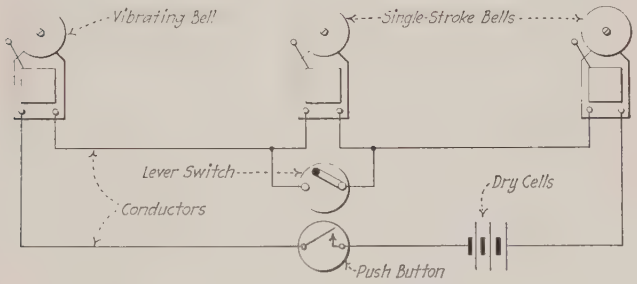


FIG. 15.—Method of connecting a single-point lever switch to silence one bell of several connected in series. When the one bell is shunted, the volume of sound which is produced by the remaining bells is increased.

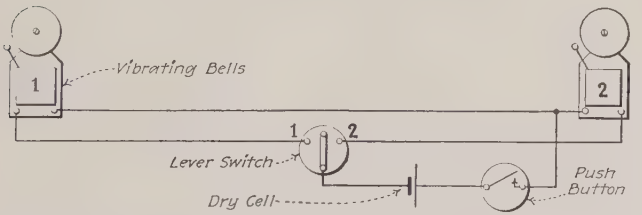


FIG. 16.—Method of connecting a two-point lever switch to obtain selective ringing of either of two bells with a single-contact push button.

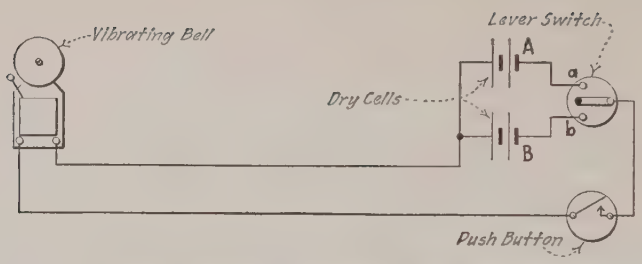


Fig. 17.—Two sets of dry cells connected so that either set may be used. When the lever switch is in position "*a*," battery "*A*" is in service, while position "*b*" renders battery "*B*" in service.

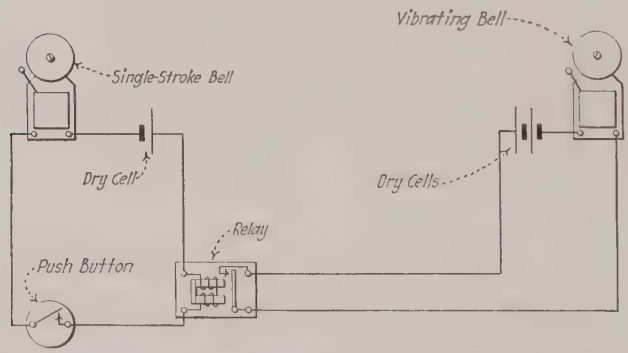


Fig. 18.—Diagram of a bell circuit with a single-stroke bell in the local battery circuit. The bell in the local circuit indicates whether or not the relay circuit is functioning.

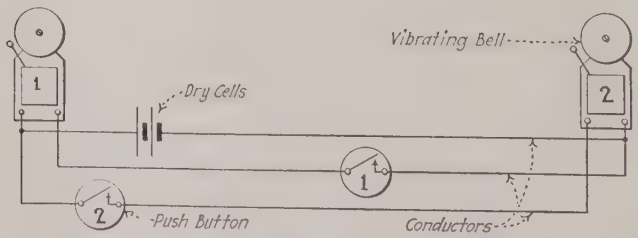


Fig. 19.—A three-wire return-cell system using single-contact buttons. When button "1" is pressed, bell "1" rings. The party at bell "1" answers the call by pressing button "2" which rings bell "2."

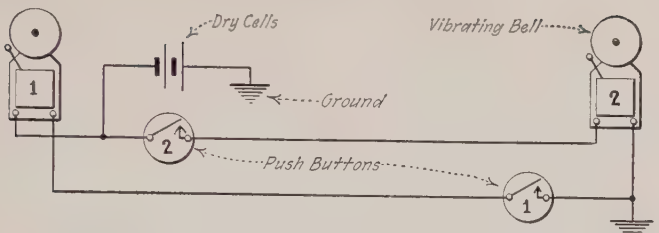


FIG. 20.—A two-wire return-call system using single-contact buttons. A third circuit is completed through the ground.

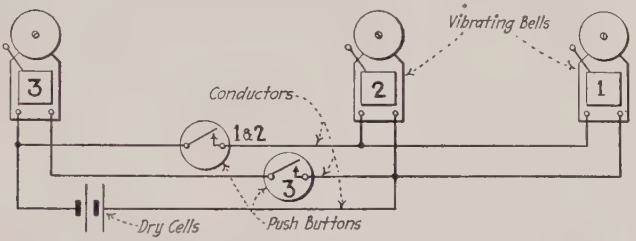


FIG. 21.—A return-call system with two bells in parallel at one end. This method may be used when an extension bell is desired at one end of the system.

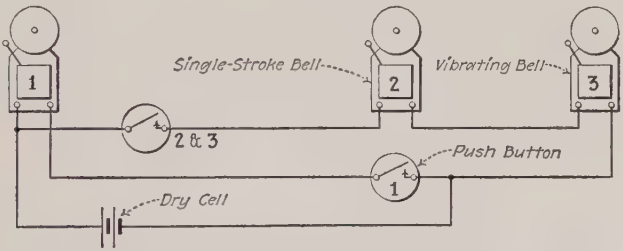


FIG. 22.—A return-call system with two bells connected in series at one end. This system requires one single-stroke and a vibrating type bell for the two bells connected in series.

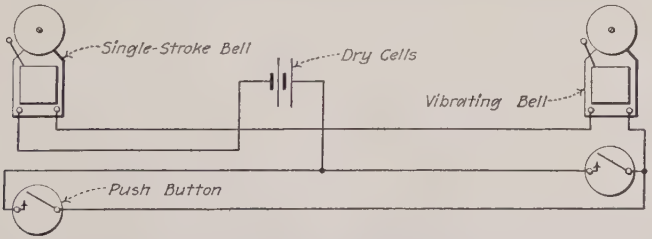


FIG. 23.—Diagram of a three-wire, series, double-call system. Each station is equipped with a bell and a single-contact push button. This, as do other series systems, requires one vibrating and one single stroke bell.

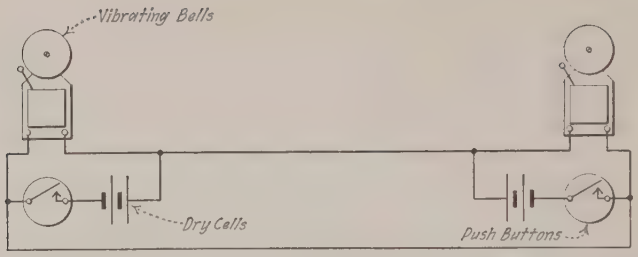


Fig. 24.—Illustrating a two-wire, double-call system. Two sets of batteries are used, one set at each station. When either button is pressed, both bells will ring simultaneously and in parallel.

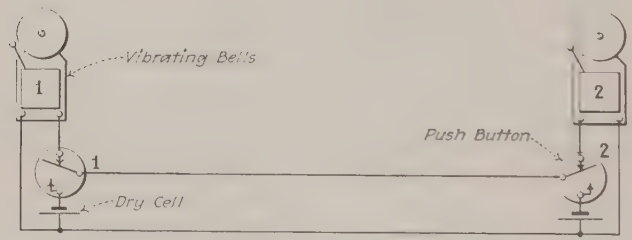


Fig. 25.—A two-wire return-call system using double-contact push buttons, and two batteries.

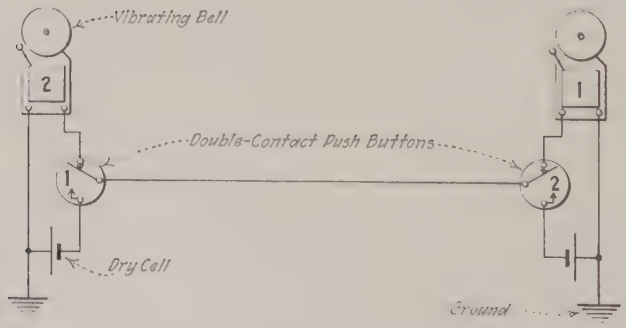


Fig. 26.—A return-call grounded system using double-contact push buttons. Only one wire is necessary between the two stations, the ground connections completing the circuit between the stations. Two sources of current are necessary.

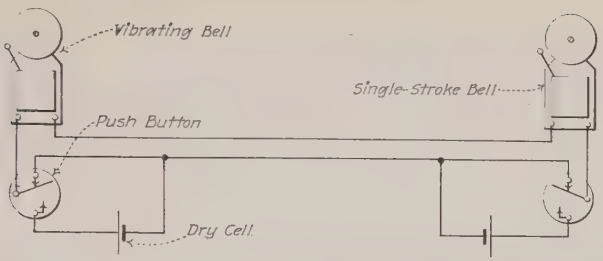


FIG. 27.—Connections for a two-wire, double-call, series system. When either button is pressed, both bells ring. A single-stroke and a vibrating bell are necessary.

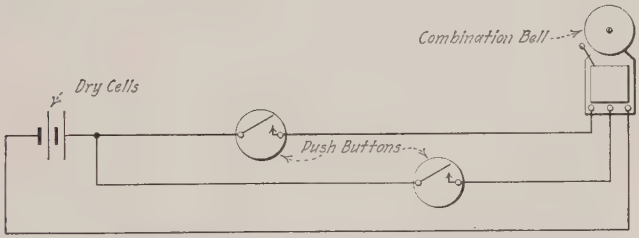


FIG. 28.—A combination bell circuit so wired that the same bell can be made to operate either vibrating or single-stroke. By pressing one button, the bell operates as a vibrating type bell while the other button operates the bell as a single-stroke type bell. A combination bell must be used for this system.

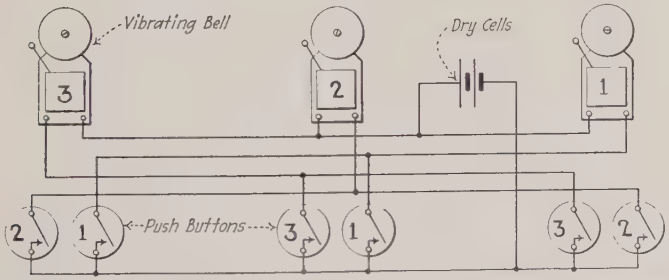


FIG. 29.—Diagram of an intercommunicating bell system. Each station requires a sufficient number of push buttons to provide for the signalling of the remaining stations.

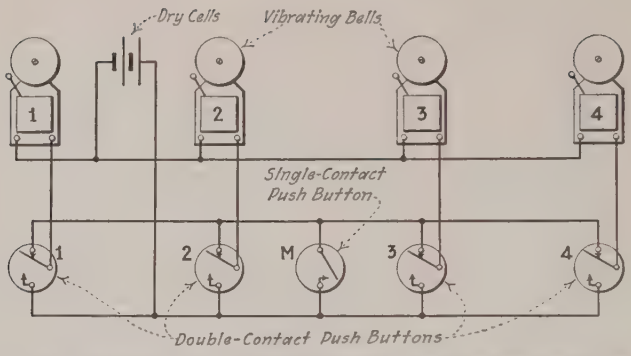


Fig. 30.—Diagram of a master-controlled bell system which employs double-contact buttons. The regular signal system can be operated by pressing the individual double-contact buttons which correspond to the bell numbers. By pressing the master button "*M*," all bells ring simultaneously and in parallel.

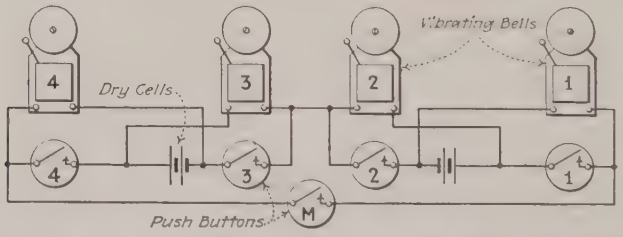


Fig. 31.—A master-controlled bell system using single-contact buttons. This circuit has the same number of stations as that shown in Fig. 30. This circuit, however, requires two sets of batteries, and the master push button operates the four bells in series.

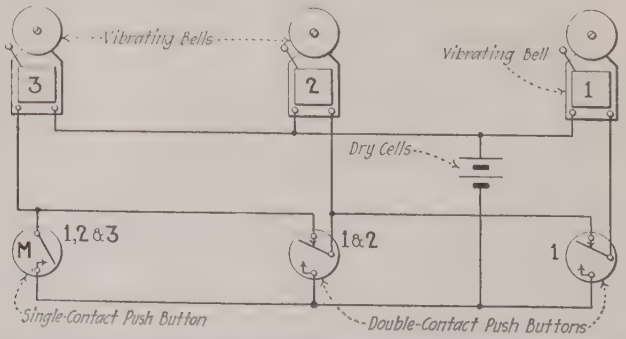


Fig. 32.—A master-controlled bell system using a combination of single- and double-contact push buttons. By pressing the various push buttons, the corresponding bells are rung.

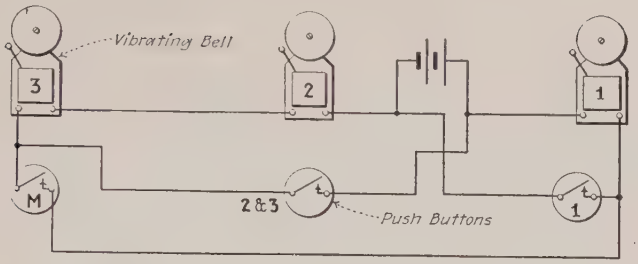


FIG. 33.—A combination master system using all single-contact push buttons. Button No. 1 rings bell No. 1, button "*M*" rings all three bells in series, while the remaining button rings bells Nos. 2 and 3 in series.

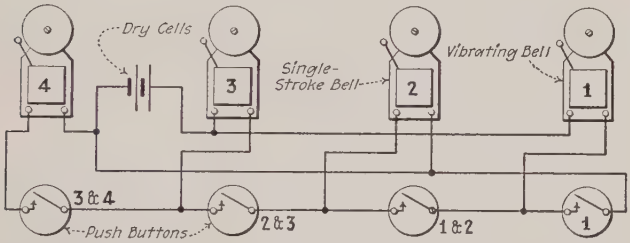


FIG. 34.—A special bell system, wherein button No. 1 operates bell No. 1 and the corresponding buttons operate bells of their respective numbers. Vibrating and single-stroke bells are required for this system.

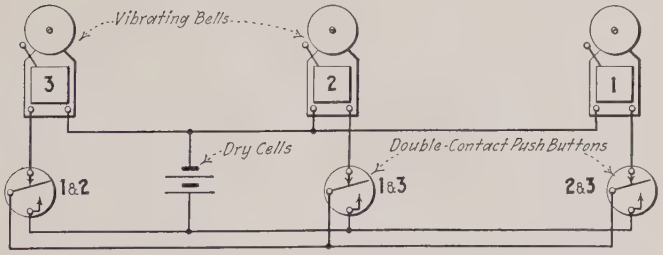


FIG. 35.—A bell system where all bells operate except the bell at the station where the button is pressed. Double-contact push buttons are employed at each station.

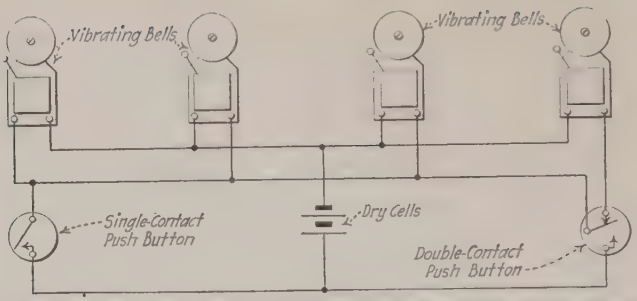


Fig. 36.—Diagram of a special bell system where a double-contact push button operates all of the bells except the one at the calling station and a single-contact button operates all bells in series.

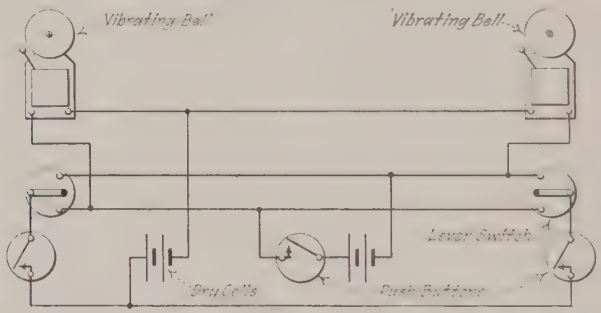


Fig. 37.—A special bell system where lever switches are used to give selective bell ringing from the two end stations and a single button at the center station which rings both stations. The bells are rung in series from the center station. Two sets of batteries are used, one set for the series operation and the other set for the ordinary operation.

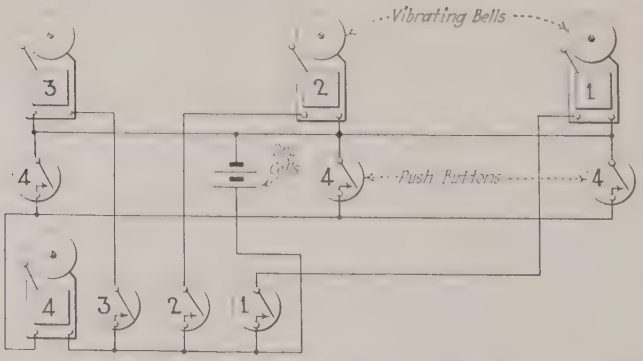


Fig. 38.—Diagram of an extensive return-call bell system, using single contact buttons.

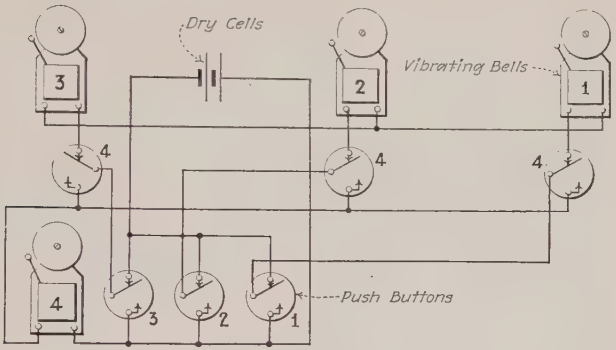


FIG. 39.—An extensive return-call bell system using double-contact push buttons.

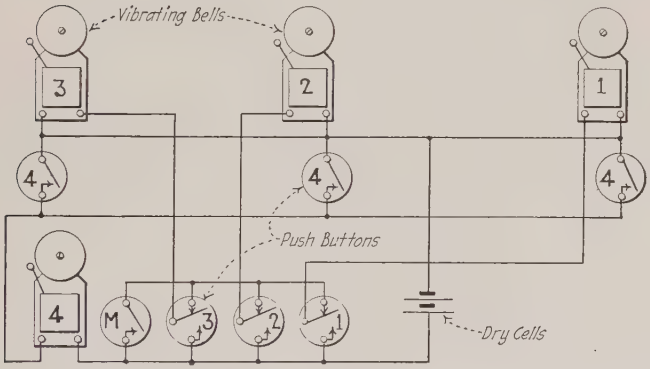


FIG. 40.—Diagram of a return-call system which employs single-contact buttons at the outlying stations and double-contact buttons at the central station. A master button is provided at the central station which rings all the bells simultaneously.

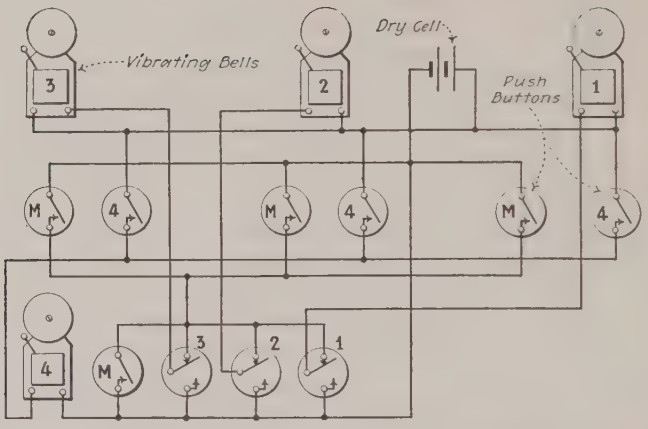


Fig. 41.—A combination return-call bell system and fire-alarm system. A master push button is provided at each station in addition to a regular call button.

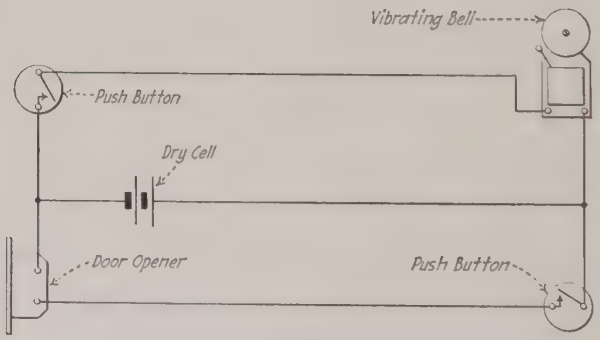


Fig. 42.—Diagram of an electric bell and door-lock circuit.

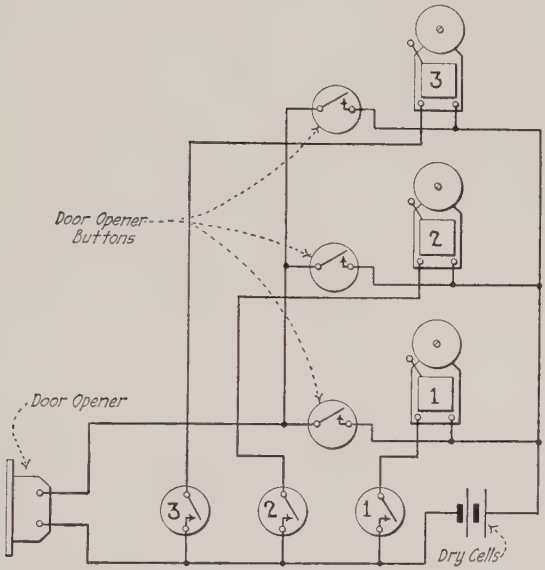


FIG. 43.—Wiring diagram for an electric bell and door-lock system for an apartment house. The lower group of push buttons is usually placed in the vestibule, so wired that they operate bells in the various apartments. The other push buttons are located in the various apartments any one of which will operate the door lock at the entrance.

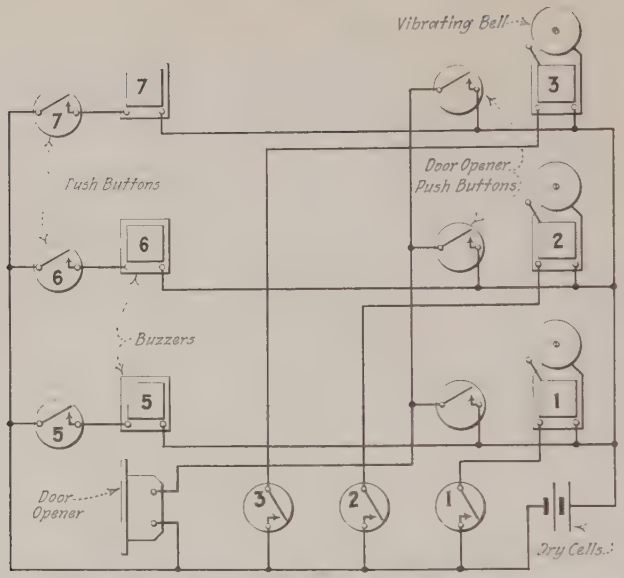


FIG. 44.—Wiring connections for an apartment signal system having entrance and hall bell signals as well as door-lock system. The push buttons operating the buzzers are located at the entrances to the apartments on the various floors. The bells indicate a signal from the main entrance. Each apartment is also provided with a push button to operate the door lock.

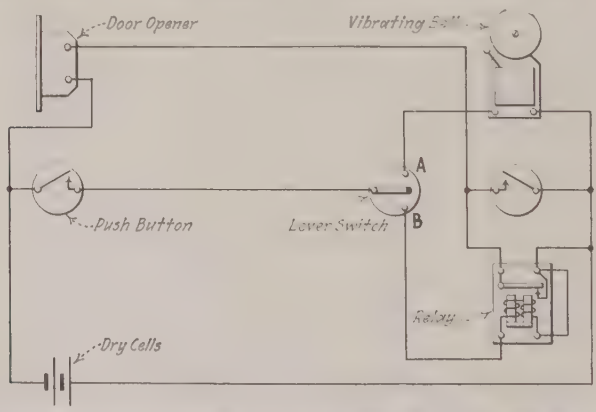


FIG. 45.—Diagram of a bell and door-lock system. This system employs a two-point lever switch and is so connected that when the lever is in position *A* the ordinary bell and door-lock system will be in operation. When the lever is in position *B*, the door lock can be operated from either push button. In the latter position the occupant can enter the apartment without a key. A relay is used in this system.

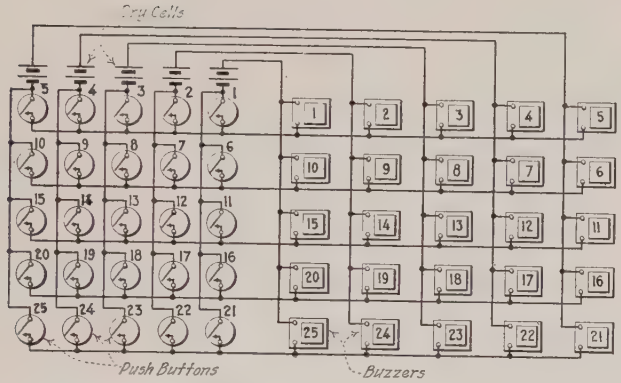


Fig. 46.—Operating 25 bells and 25 push buttons with ten wires. Five sets of batteries are required.

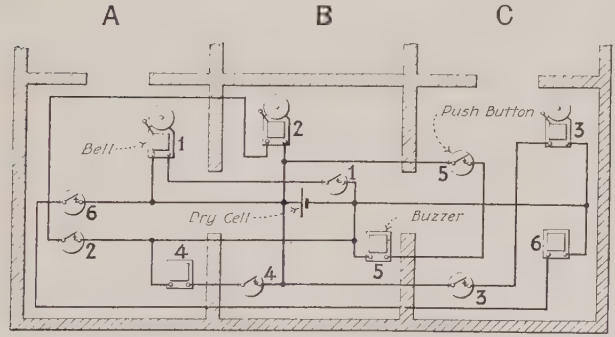


Fig. 47.—Bell and buzzer circuit connection for sending signals from any one of three rooms to any of the other rooms in such a manner as to indicate from whence the signal came. For example, by pressing button 2 in room *A*, a signal will be sounded by bell 2 in room *B*. By pressing button 6 in room *A*, buzzer 6 in room *C* will be sounded. In room *B*, by pressing button 1, bell 1 in room *A* will be sounded and by pressing button 4 in room *B*, buzzer 4 in room *A* will be sounded

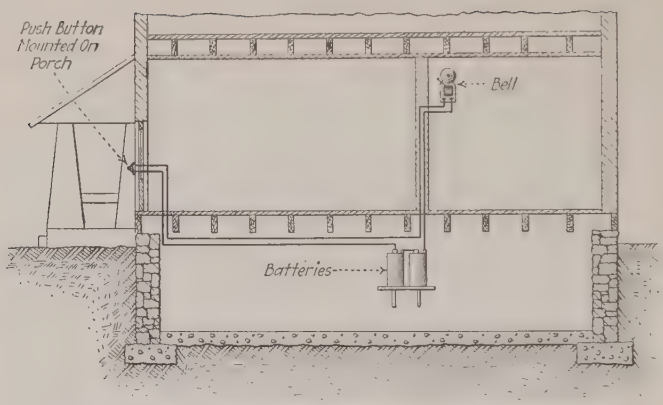


Fig. 48.—Illustrating the installation of a simple bell circuit.

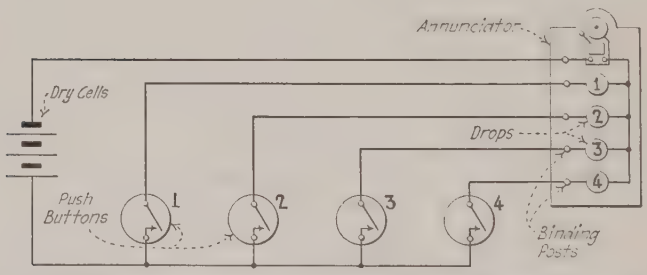


Fig. 49.—Illustrating the connections of a four-drop annunciator circuit

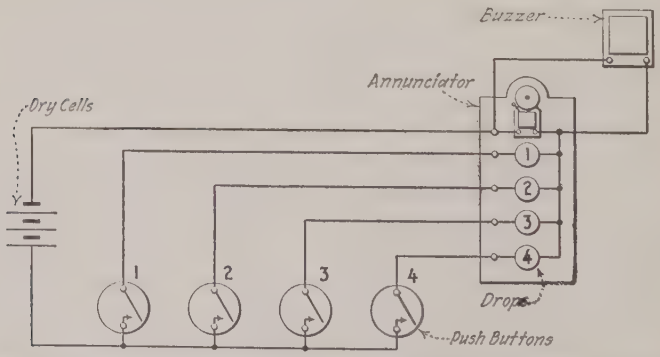


Fig. 50.—Connections for an extension bell for an annunciator system.

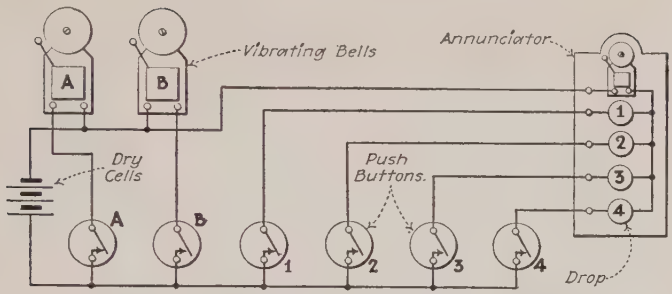


FIG. 51.—Combination bell and annunciator system.

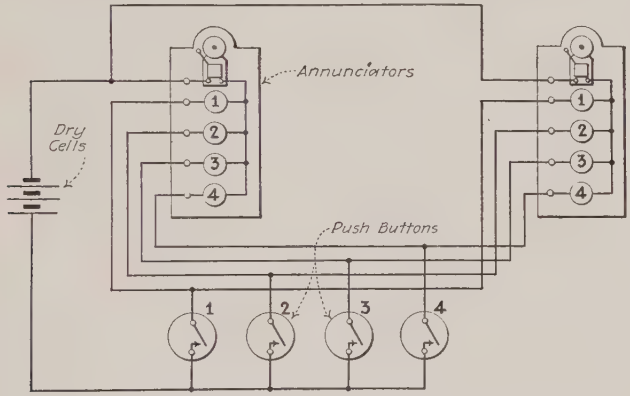


FIG. 52.—Wiring diagram of two annunciators in parallel.

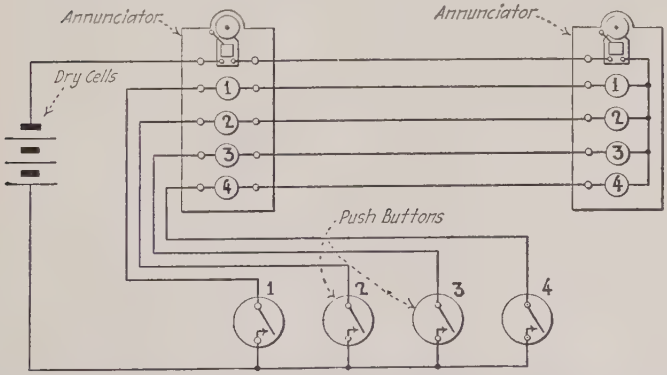


FIG. 53.—Old method of connecting two annunciators in series. The parallel connection, which is shown in the preceding illustration, is the preferable one.

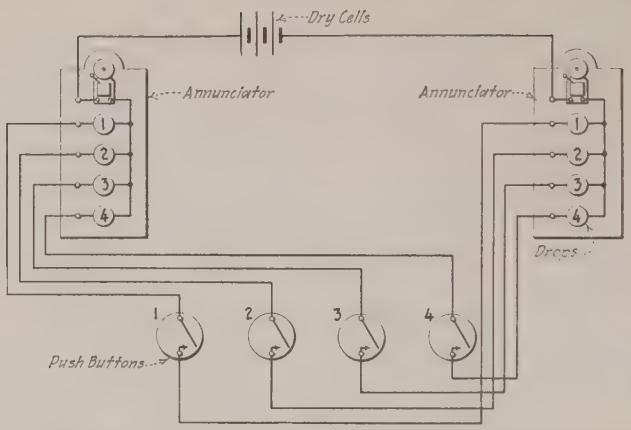


Fig. 54.—Modern method of connecting two annunciators in series. The parallel connection is preferable.

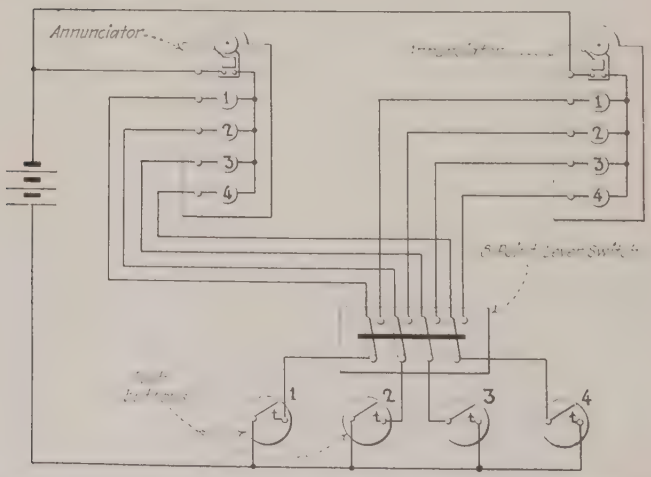


Fig. 55.—Controlling two annunciators with a lever switch so that either may be operated independently of the other.

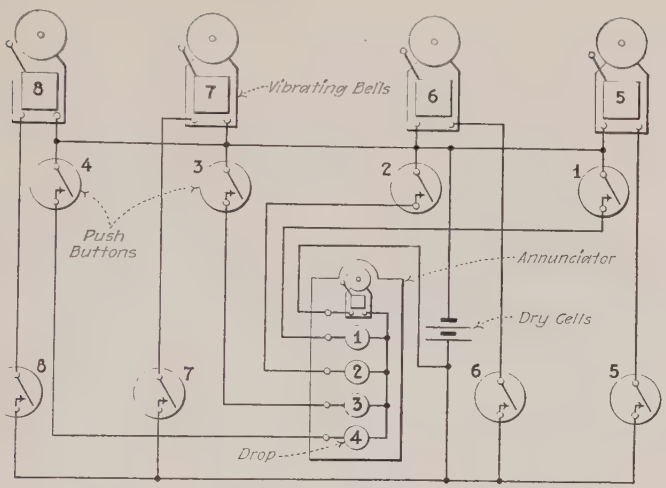


FIG. 56.—Diagram of a return-call annunciator system using single-contact buttons.

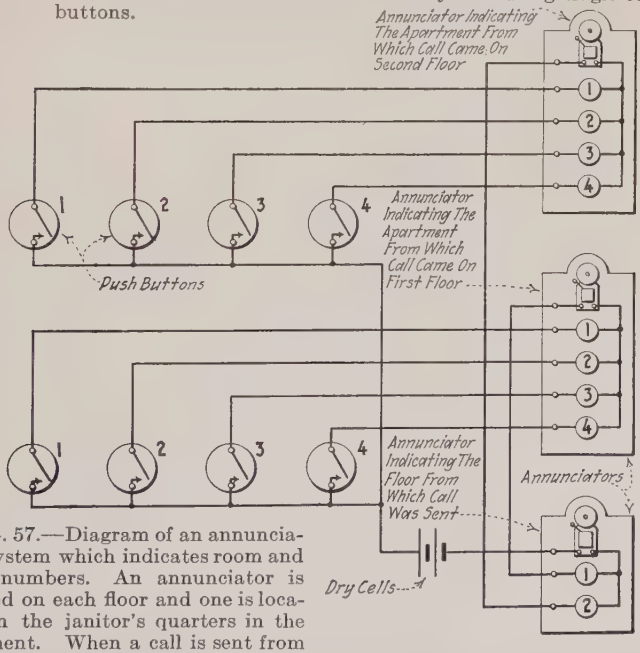

Annunciator Indicating The Apartment From Which Call Came On Second Floor
1
2
3
4
Annunciator Indicating The Apartment From Which Call Came On First Floor
Push Buttons
Annunciator Indicating The Floor From Which Call Was Sent
Annunciators
Dry Cells

FIG. 57.—Diagram of an annunciator system which indicates room and floor numbers. An annunciator is located on each floor and one is located in the janitor's quarters in the basement. When a call is sent from an apartment for the janitor, the annunciator in the janitor's quarters indicates the floor from which the call came. The janitor then goes to the annunciator on the floor from which the call came and notes from which apartment the call was sent.

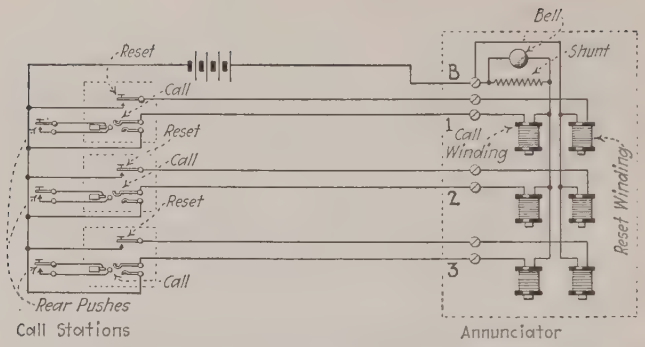


Fig. 58.—Wiring diagram of an individual-reset annunciator system. (S. H. Couch Co., Inc.

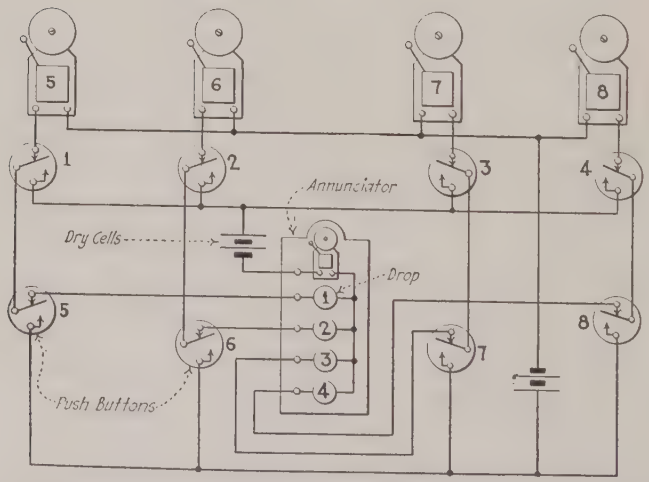


Fig. 59.—Return-call annunciator system, using double-contact buttons, with two sources of current.

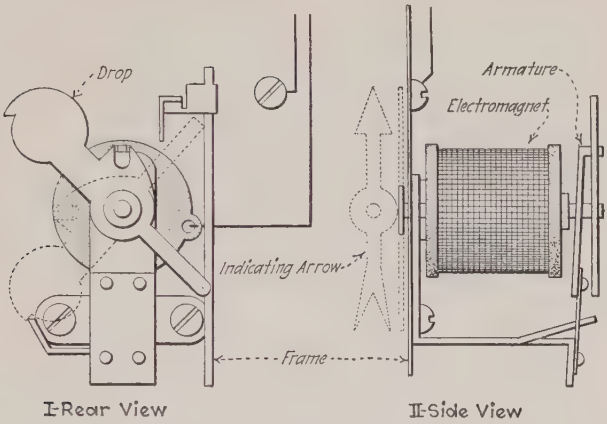


Fig. 60.—Details of the construction of an annunciator drop.

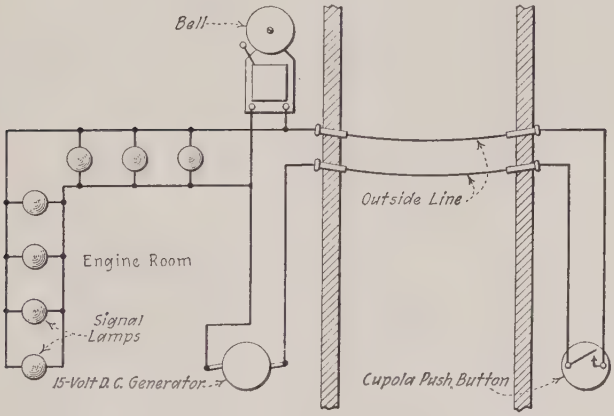


Fig. 61.—Wiring system for a reliable signal system in a foundry. Energy may be furnished by either a low-voltage direct-current generator or by a storage battery. Code signals are transmitted by operating the cupola push button. The red low-voltage lamps "blink" simultaneously with the sounding of the bell.

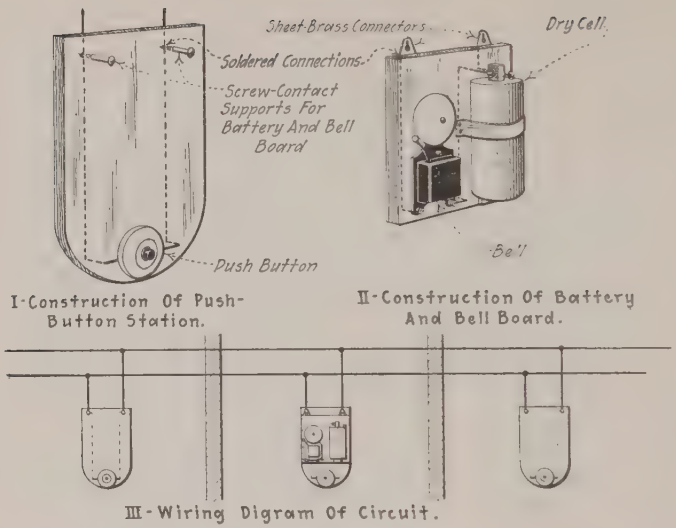


Fig. 62.—A call bell system having push button and bell-and-battery units. Each station is permanently equipped with a push-button unit as shown in *I*. The bell-and-battery unit may be installed at any station by merely hanging it on the supporting screws, on the push button back board, which also complete the electrical connections for the bell and battery. Push-button units may be installed permanently in a number of rooms; then the bell-and-battery unit may be connected, temporarily, in those different rooms in which it is desired that the signal be heard when a push button is pressed.

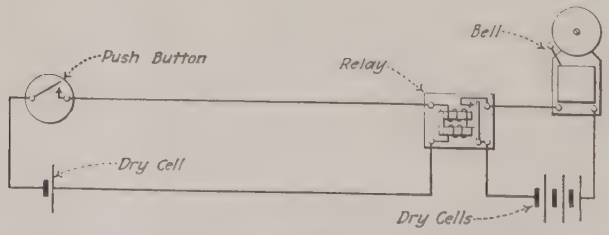


Fig. 63.—Bell circuit with relay. This system is used where the push button is located in a remote place.

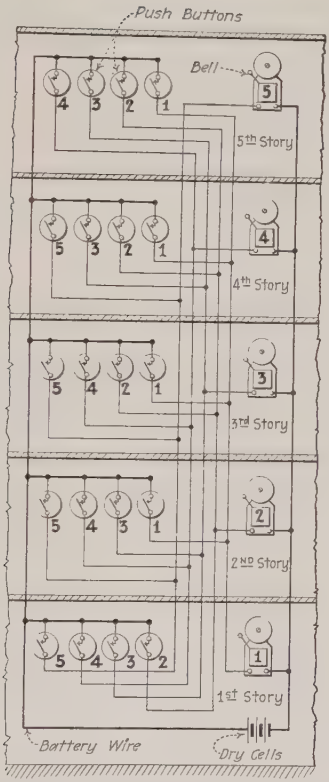


FIG. 64.—Speaking tube system operated from one battery. Each station can be signalled from any other station.

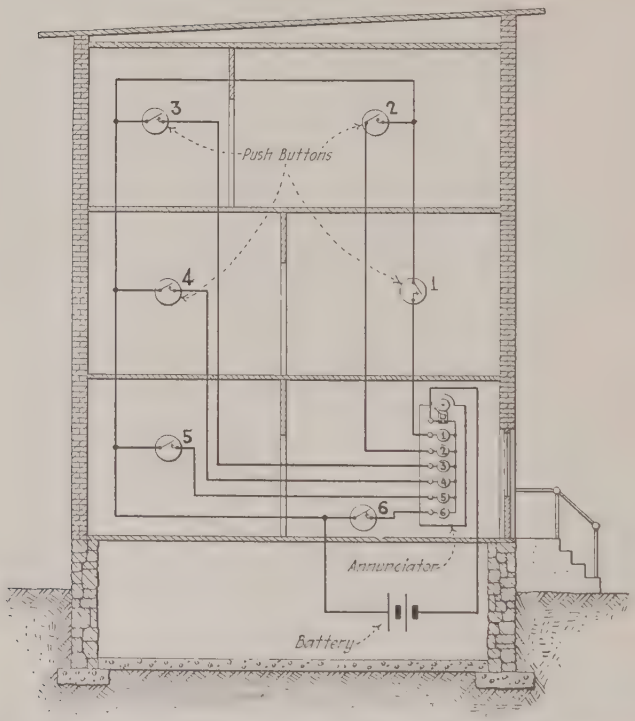


Fig. 65.—Wiring diagram of an annunciator system installed in a residence.

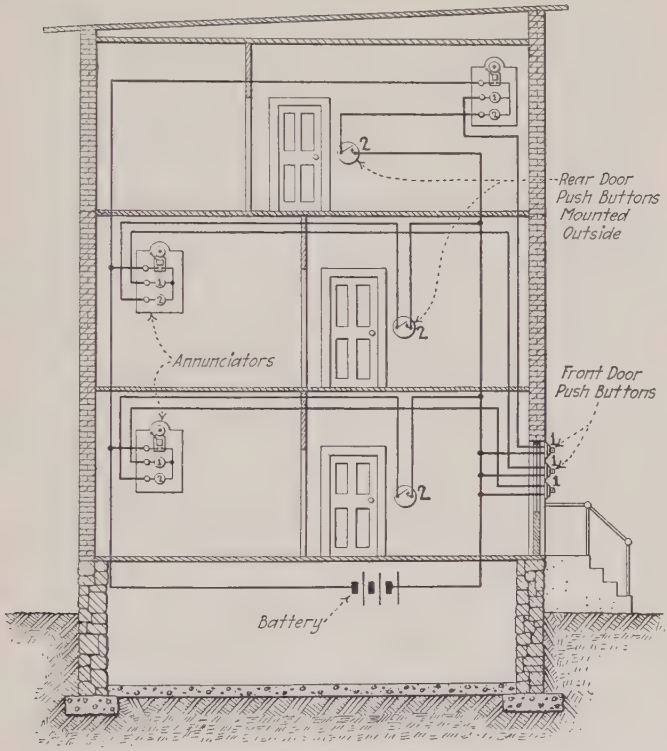


Fig. 66.—An annunciator system for an apartment which is provided with push buttons at the front and the rear doors. A double-drop annunciator, located in each apartment, indicates whether the call came from the front or the rear door.

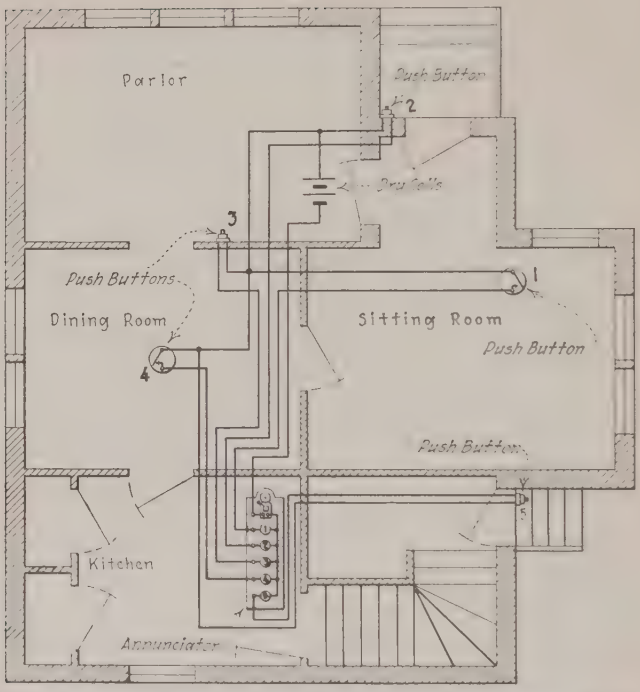


Fig. 67.—Floor plan of an annunciator circuit for a residence. Wires to be run on basement ceiling.

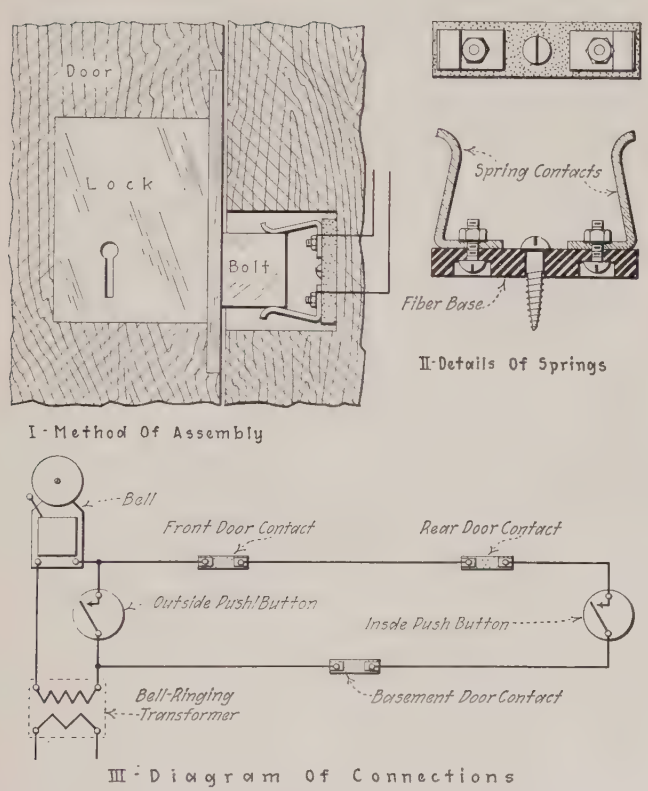


FIG. 68.—A simple arrangement for a door-lock indicator. It will, upon the owners retiring, when he presses the inside push button, indicate by the ringing of the bell, that all doors in the house are locked.

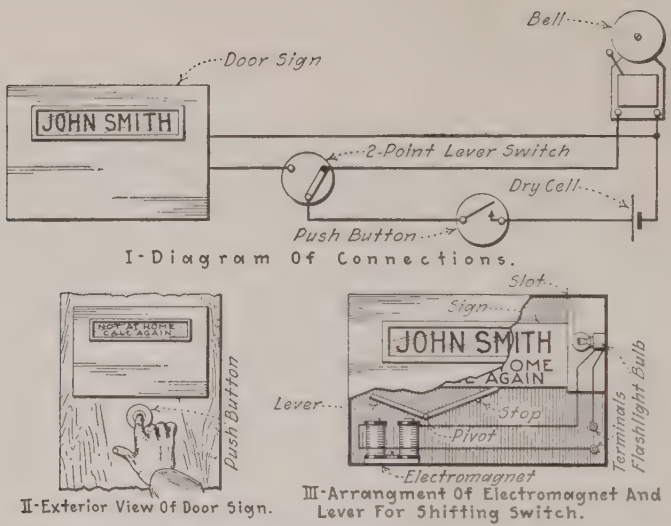


Fig. 69.—An electrically-operated door sign which will indicate when the occupant is out or when he will return, and to give any other information of that character by the touching of a button. When the owner is at home, he turns the two-point switch to the upper contact; pressing the push button will ring the bell; the nameplate will show the name only. When the owner is not at home, the two-point switch is thrown to the lower contact; then pressing the button will raise the "Not at Home, Call Again" sign into view. (*Practical Electrics*, October, 1923.)

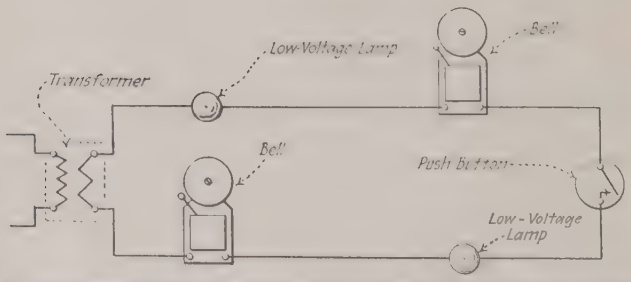


Fig. 70.—A simple series arrangement for visual and audible signalling.

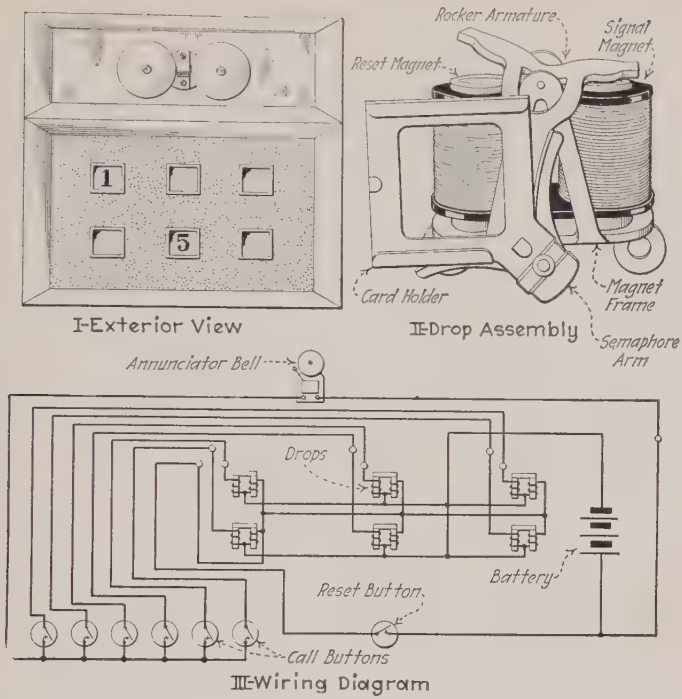


FIG. 71.—Illustrating a Western Electric Company annunciator.

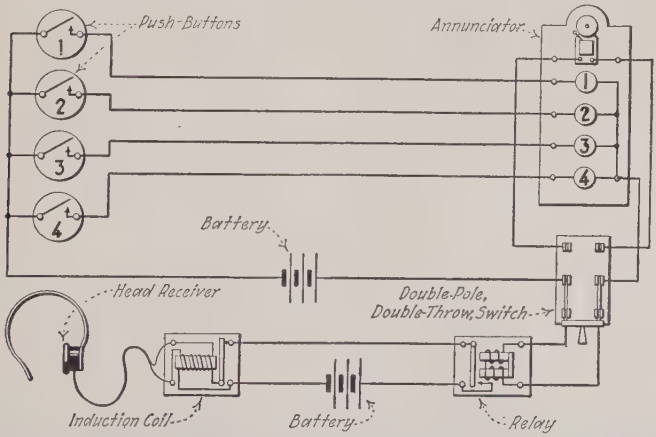


FIG. 72.—Wiring of a steamboat annunciator to insure quiet operation at night. Throwing the double-pole switch substitutes the noiseless head-telephone (which the attendant wears) for the annunciator gong.

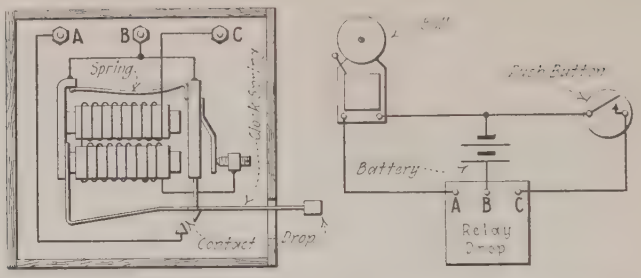


Fig. 73.—Converting a vibrating bell system into a constant-ringing bell system by providing a circuit-closing relay.

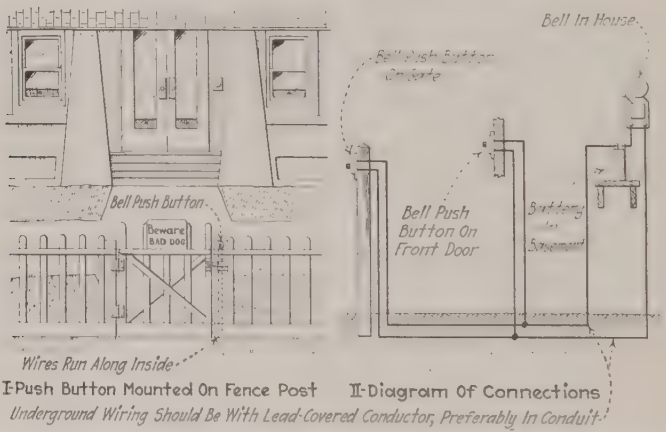

Bell Push Button
Beware
BAD DOG
Wires Run Along Inside
Bell In House
Bell Push Button On Front Door
I-Push Button Mounted On Fence Post
II-Diagram Of Connections
Underground Wiring Should Be With Lead-Covered Conductor, Preferably In Conduit

Fig. 74.—Elevation and diagram of connections for ringing the front-door bell from the outer gate.

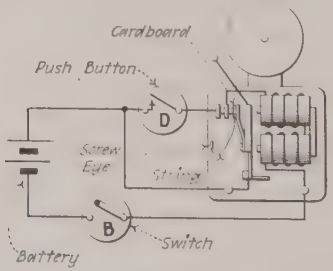


Fig. 75.—A simple constant-ringing bell. A piece of cardboard is placed between the armature and contact screw of the bell. With lever switch *B* closed, the closing of the push button, *D* energizes the bell magnets, drawing the armature to the magnets, thus releasing the piece of cardboard and setting the bell into operation.

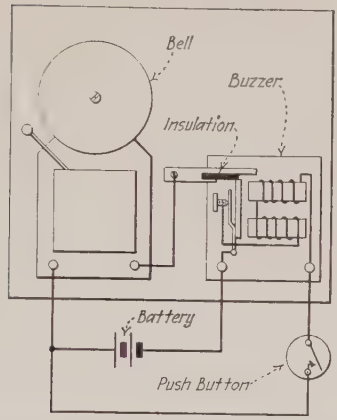


FIG. 76.—A constant-ringing drop improvised from an electric bell or buzzer.

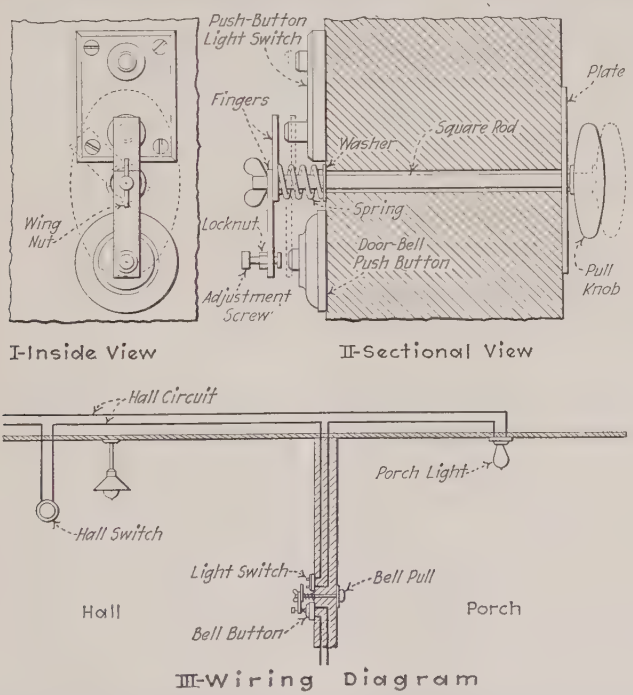


FIG. 77.—Ringing the door bell switches on the porch lights. When the knob is pulled outward, the push button is depressed, ringing the bell; the switch button is pressed in, and the porch light is turned on, both at the same time.

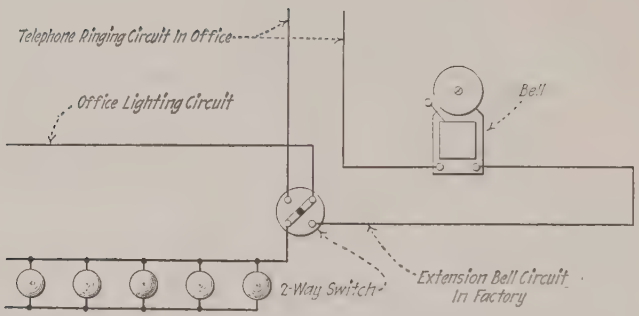


Fig. 78.—An automatic cutout for an extension bell. The idea of this arrangement is to connect an extension bell, for the telephone, into the factory when the office is closed. Artificial light is always necessary in the office; hence a two-way switch was so connected that when someone is in the office and the lights are on, the extension bell is disconnected; when the bokkeeper leaves the office, and turns off the lights he also, at the same time, connects the extension bell. This arrangement is contrary to the provisions of the *National Electrical Code* which prohibits the connection of a signal circuit to a switch on which power voltage is impressed.

DIVISION 2

BURGLAR ALARMS

DIVISION 2

BURGLAR ALARMS

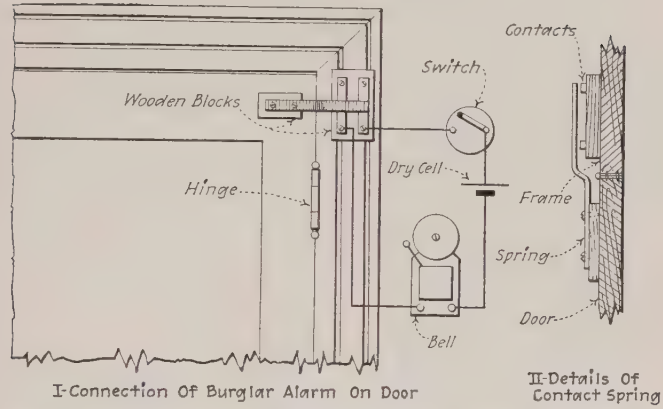


FIG. 79.—A simple door alarm which causes the bell to ring when door is opened.

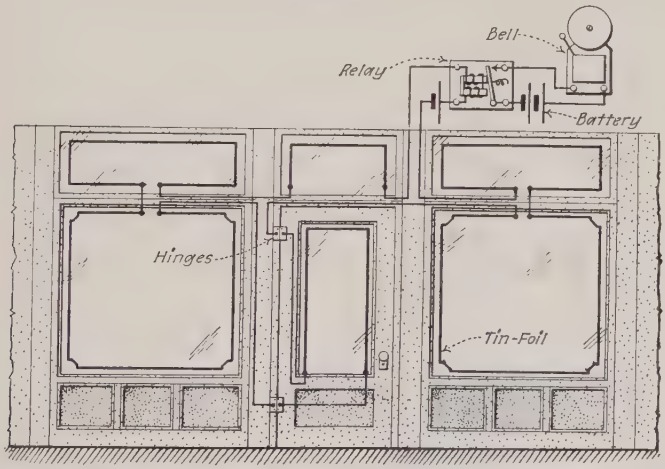


FIG. 80.—A closed-circuit burglar-alarm system used extensively for store-front protection. Strips of tin foil are shellaced to the window and door glasses. These strips form the closed circuit. If the glass is broken, the closed circuit is opened and the alarm is set off. The tin foil is frequently placed on the glass in the form of a design; it then serves a decorative, as well as protective purpose.

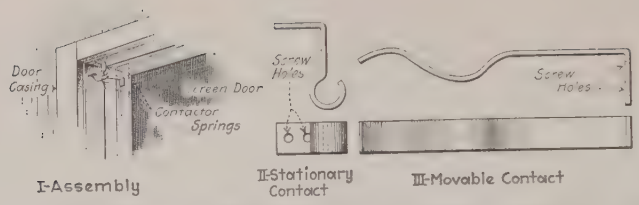


Fig. 81.—Details and assembly of an alarm-circuit contactor for a screen door. This contactor provides only a momentary contact; therefore the bell rings only for a short interval as the door is being opened or closed. One conductor of the bell circuit is connected to the spring, which is mounted on the door, while the other conductor is connected to the screen-door frame.

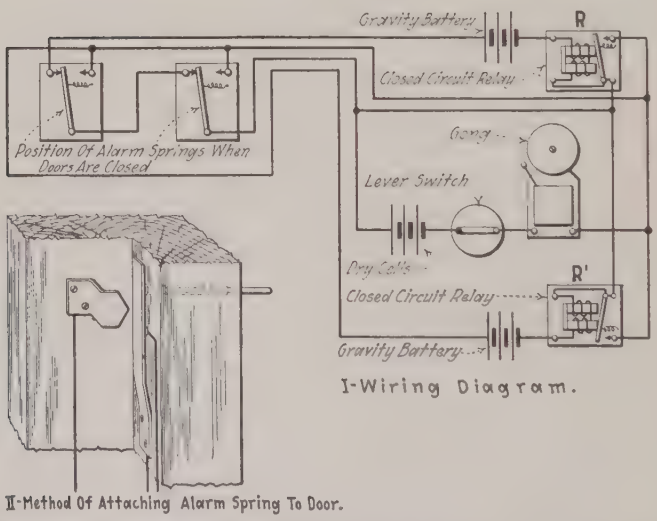


Fig. 82.—A combination open- and closed-circuit burglar-alarm system. The idea of the system is that if any of the wires are cut or if the wires are shorted, the alarm will sound the same as if the door is opened. If conductors in the upper relay circuit are cut, or the door is opened, the magnet circuit, of relay *R* is de-energized releasing the lever and closing the circuit through the alarm. When the door spring opens, a second contact is made which closes the bell circuit which works in conjunction with the relay contacts. (*Practical Electrics*, Oct., 1922.)

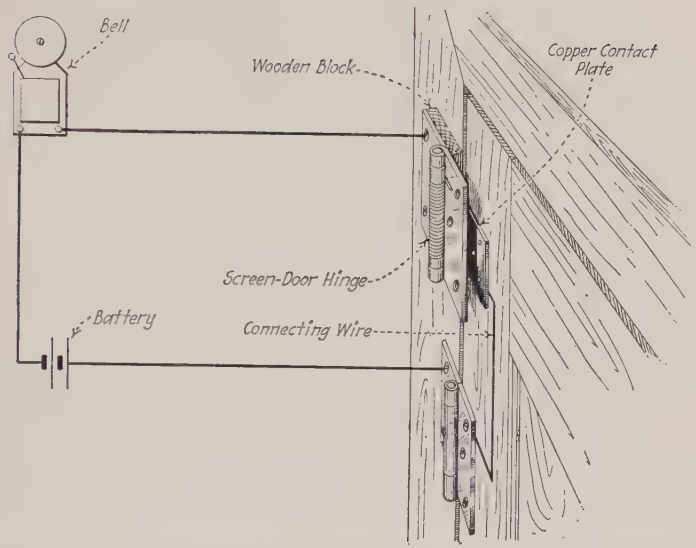


FIG. 83.—An improvised scheme for a door burglar alarm which uses a spring hinge as the circuit closing device.

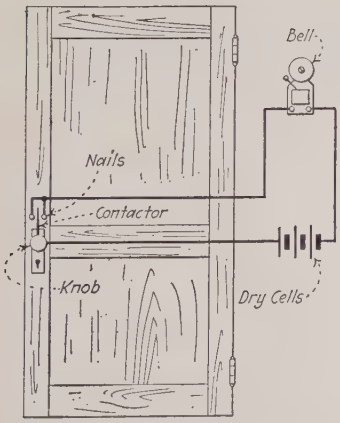


FIG. 84.—A simple improvised burglar alarm which rings a bell when the knob of the door is turned.

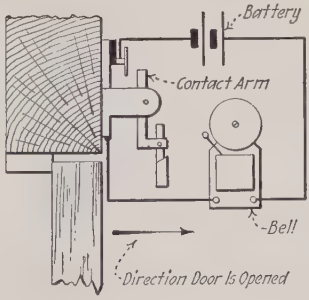


FIG. 85.—A door trip alarm attached to a door to ring a bell when the door is opened.

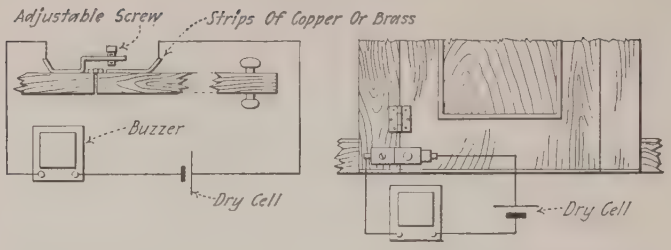


Fig. 86.—A simple burglar alarm which has a screw contact which may be so adjusted that the alarm will be sounded either when the door is slightly opened, or only when it is opened more widely.

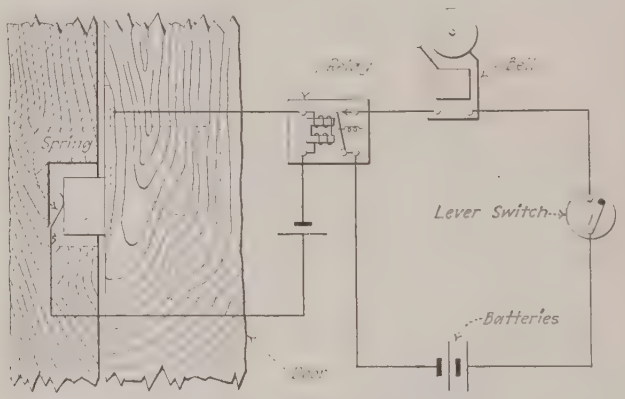


Fig. 87.—An electric burglar alarm connected to a door lock.

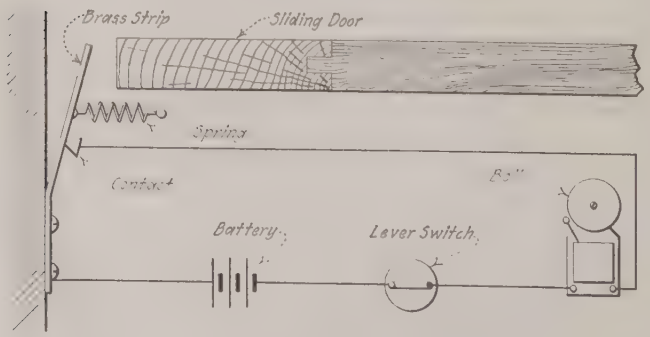


Fig. 88.—Burglar alarm for sliding door.

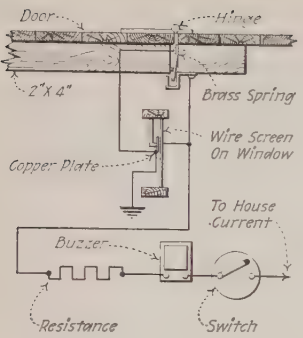


FIG. 89.—Diagram of a chicken house alarm. The ground and "hot" side of the lighting circuit are used to energize the circuit. This system is contrary to the provisions of the National Electrical Code and cannot be employed where local ordinances prohibit the use of such connections. Opening the door closes the signal circuit. A resistance, possibly a lamp, bridged around the buzzer would tend to protect the buzzer contacts from damage by arcing. (*Electrical Experimenter*, March, 1918.)

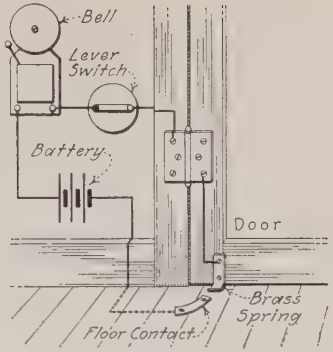


FIG. 90.—A home-made door alarm contactor. An alarm is sounded when the door is opened. It ceases to ring when the door is wide open, and also when the door is closed.

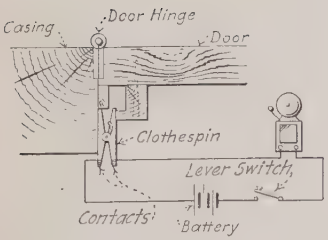


FIG. 91.—A clothespin door-alarm contactor.

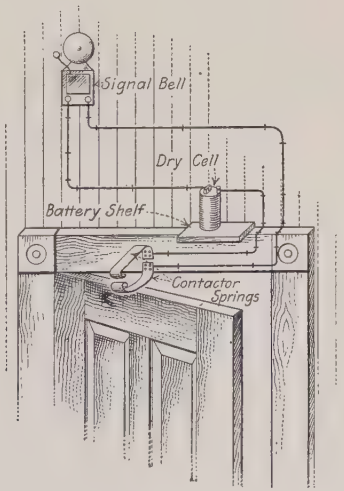


FIG. 92.—Instantaneous-ringing door contactor.

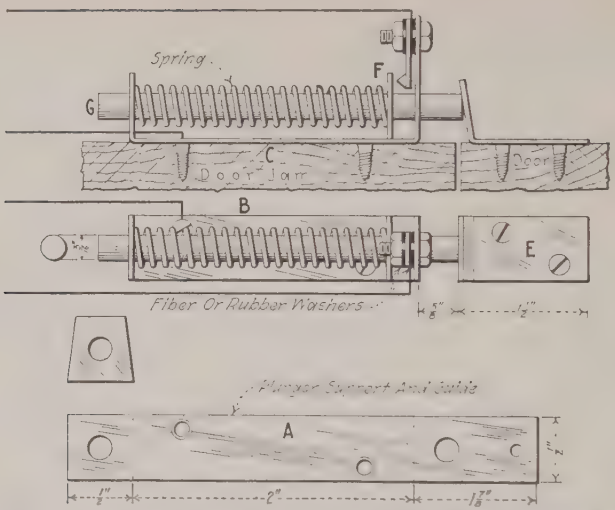


Fig. 93.—An igenious form of contact device for a burglar-alarm system. The spring contact making device *B* is screwed onto the door jamb, and is normally held open by the angle strip *E* which is fastened to the door. Whenever the door is opened, the spring forces the plunger out, closing the contacts *F* and sounding the burglar alarm.

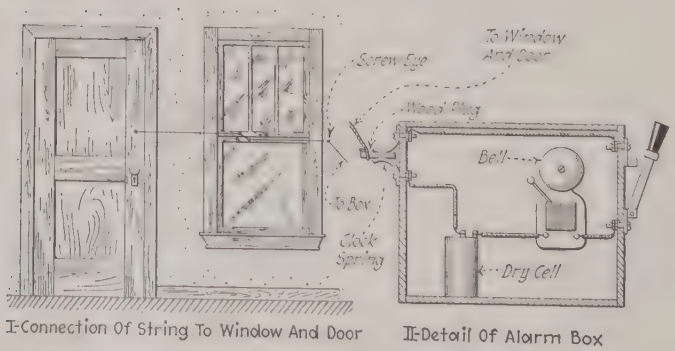


Fig. 94.—Diagram of connections and construction of a simple mechanical-electrical burglar alarm. It protects the door and window by utilizing a fine thread to pull out the pin, which permits the circuit-closing springs to close the bell-ringing circuit.

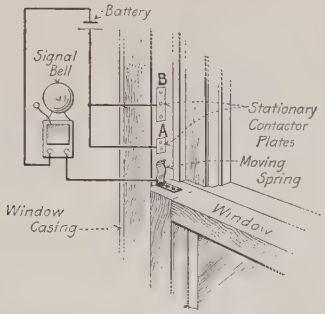


FIG. 95.—An alarm contactor for a window. The stationary contacts are so arranged as to permit the window to be opened sufficiently to permit proper ventilation. If the window is slightly raised or lowered, contact is made with strip "*A*" or "*B*" which closes an alarm circuit.

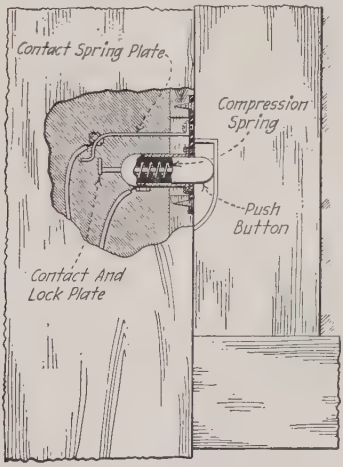


FIG. 96.—A window alarm switch which operates by the opening of the window to which it is attached. The alarm is an automatically locking push button which fits into the window frame just above the lower window. A flat-head bolt is screwed in back of this push button and makes contact with the iron mounting in which it slides. The bolt and the button are normally pushed to their outer-most position by a spring inside the mounting. When the window is raised, the push button is depressed closing the alarm circuit by the contact of the spring plate and bolt. The iron finger prevents the bottom from being brought back, so if the window is closed the alarm continues to ring. By turning the button in a certain position, a notch in the flat head of the bolt will come opposite the finger and the bolt-head can slide through.

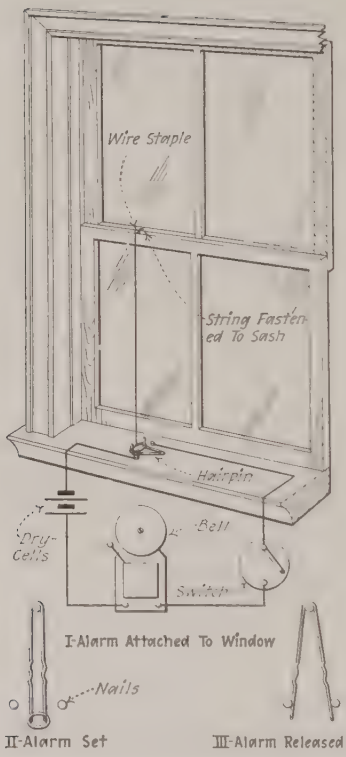


Fig. 97.—An improvised window burglar alarm employing a hair pin as a circuit-closing contactor.

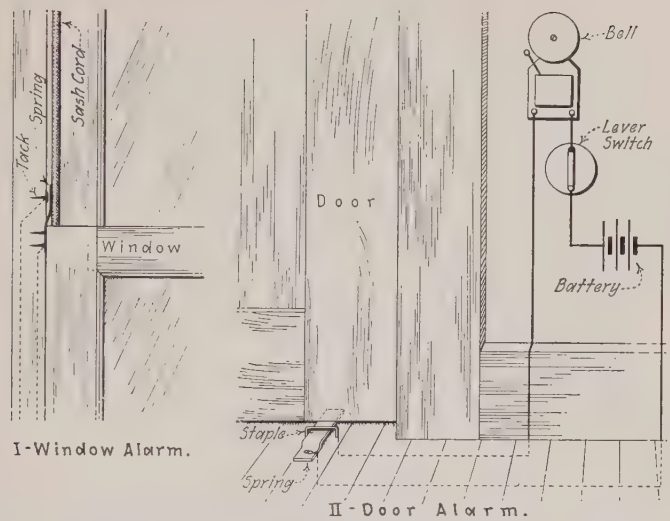


FIG. 98.—A simple home-made burglar alarm which closes an alarm circuit when the door or window to which the device is attached, is opened.

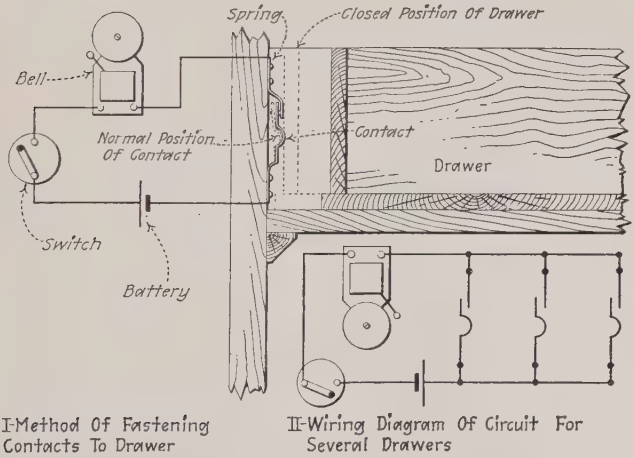


FIG. 99.—A home-made drawer alarm. When the drawer is pulled out, even slightly, the switch spring closes and rings the bell.

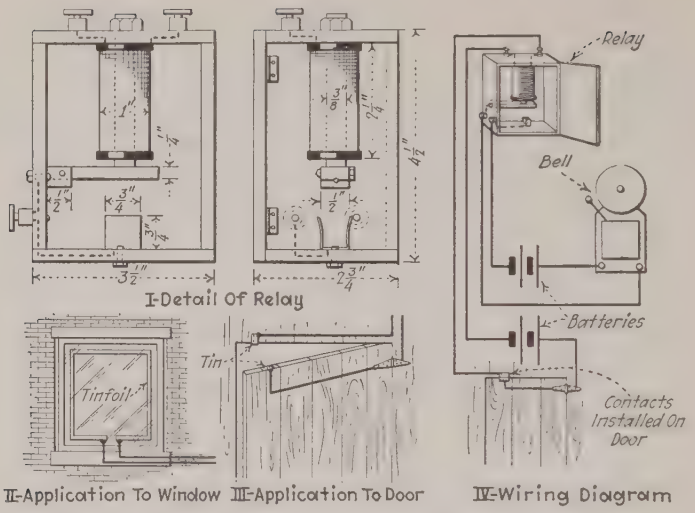


Fig. 100.—Another closed-circuit burglar-alarm system using a home-made relay.

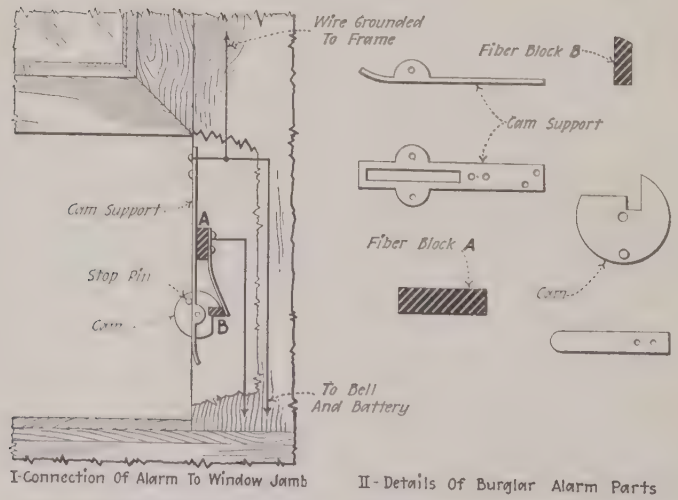


Fig. 101.—An electric window alarm. The device is operated by the turning of a roller by the sash when it is pushed up or down.

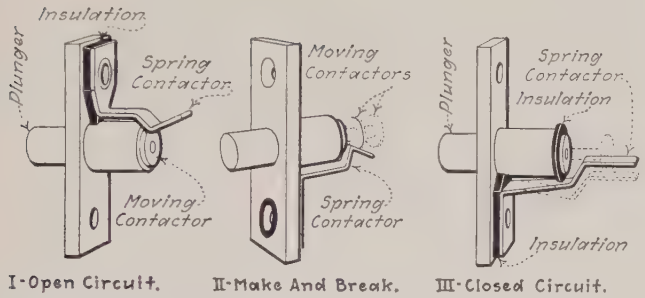


FIG. 102.—The three types of burglar-alarm door springs.

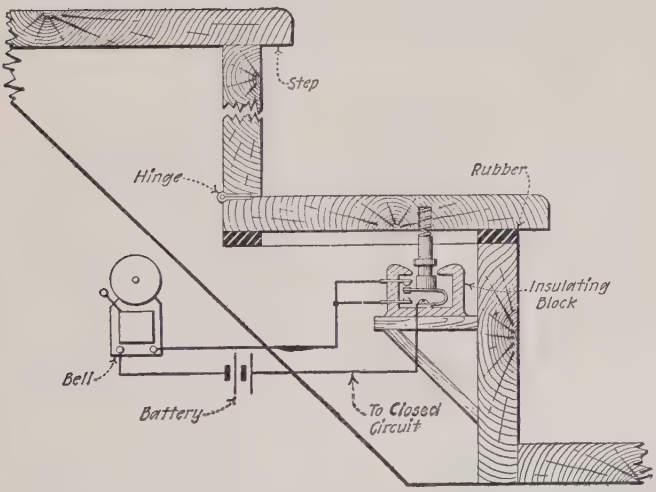


FIG. 103.—Illustrating a door-step burglar alarm. An alarm circuit is operated when the tread of the stair is stepped upon or raised.

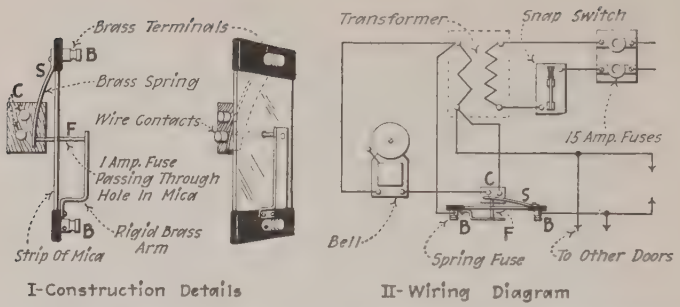


Fig. 104.—A simple burglar-alarm circuit employing a relay which functions by the fusion of a piece of fine wire. The illustration in *I* shows the construction of the alarm-circuit closer. The main feature of the circuit closer is a spring contactor "*S*," which is held away from contacts *C* by means of a fine fuse wire, *F*. This fuse wire is connected into an open-circuit burglar-alarm system, through terminals *BB*. When any of the burglar alarm springs is closed a current passes through the fuse wire, which melts it and permits the spring contactor "*S*" to close the circuit between contacts *C*. The closing of the circuit connected across contacts "*C*" sounds the alarm which rings until the fuse wire is replaced and the burglar alarm spring is reset.

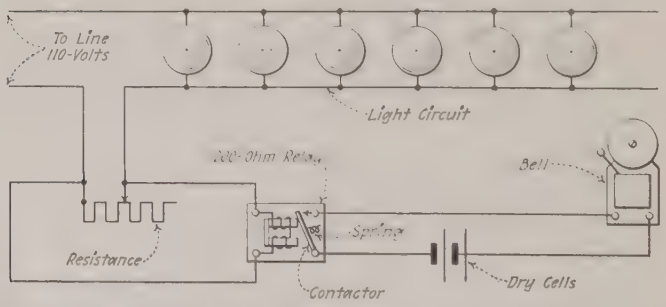


Fig. 105.—Diagram of a circuit which sounds an alarm whenever lamps are removed from the lighting circuit. The spring on the relay is so adjusted that, with all of the lamps burning, the current through the relay coils is sufficient to hold the contactor over and keep the alarm-bell circuit open. If a lamp is removed, the current through the relay coils is correspondingly decreased. The spring will then pull the contactor against its contact, closing the alarm circuit and ringing the bell.

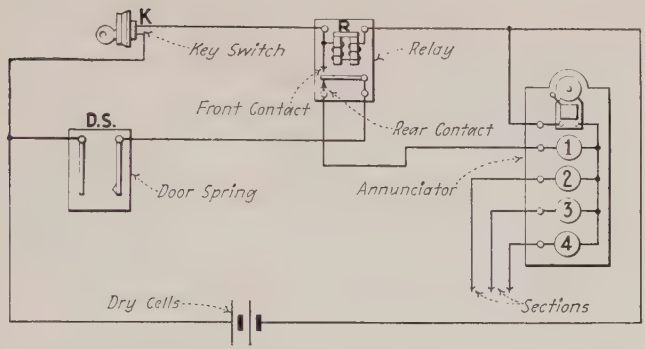


FIG. 106.—A burglar-alarm switch which permits the owner or occupant to enter the dwelling, after the instrument has been set for the night, without sounding the alarm. In this system, when the key is inserted in the lock "*K*" and turned, a current flows through the relay "*R*" drawing up its armature and breaking the front door circuit. The door is then unlocked with the regular key and opened, causing the burglar-alarm spring "*DS*" to close. Now since the burglar-alarm contact and the key contact are in parallel, the key can be withdrawn without releasing the relay. When the door is then closed the burglar-alarm contact "*DS*" will be broken, thereby allowing the relay armature to fall back, restoring the front door circuit to normal. The apparatus is practically foolproof.

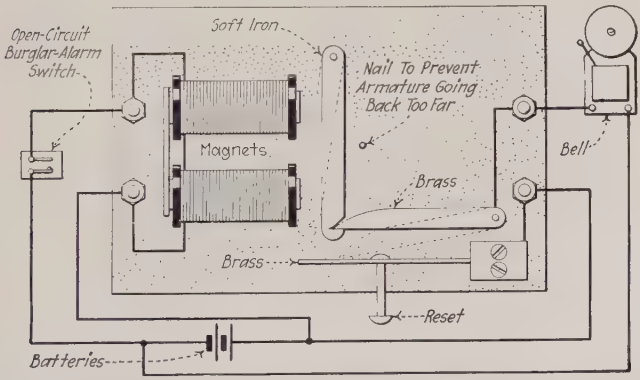


FIG. 107.—Wiring diagram for a burglar-alarm system, which has a continuous-ringing relay so connected that the alarm bell continues to ring (until the relay has been reset) after the alarm circuit has once been closed. The dotted lines show the positions of the armature and brass drop after the relay has been released by the closing of the alarm circuit.

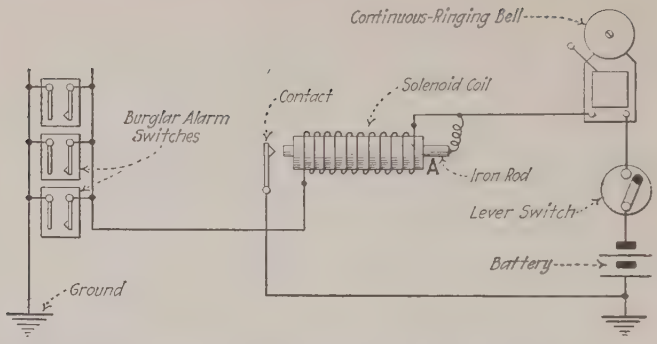


Fig. 108.—Wiring diagram of a continuous-ringing burglar-alarm system actuated through a solenoid coil and a return ground. The iron core *A* of the solenoid is arranged so that when the coil is energized it pulls the rod in, thus causing the end of it to make contact with the point of the spring. This closes the local bell circuit which sets the bell into operation. To reset, the iron core is withdrawn.

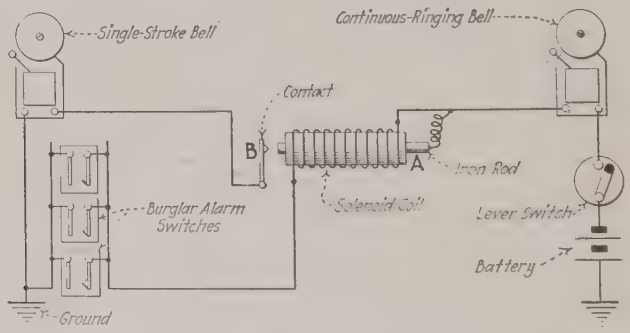


Fig. 109.—Burglar-alarm system shown in Fig. 108 operating two bells. This system is a modification of the one shown in Fig. 108. In this case, instead of a simple-local circuit there is provided an additional single-stroke bell. When any of the contact springs make contact and the solenoid is energized, the iron rod *A* engages the contact *B* and thus closes the circuit of both bells.

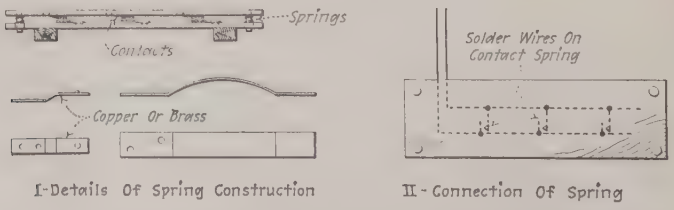


Fig. 110.—A floor burglar-alarm switch in the form of a floor board.

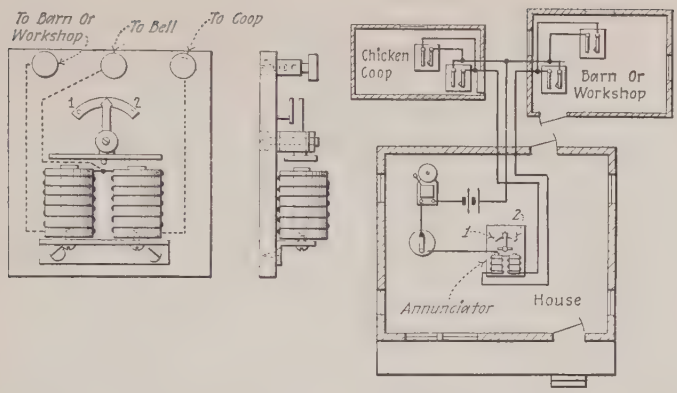


FIG. 111.—A small burglar-alarm system indicating annunciator which can be constructed from odd parts which may be found around the shop.

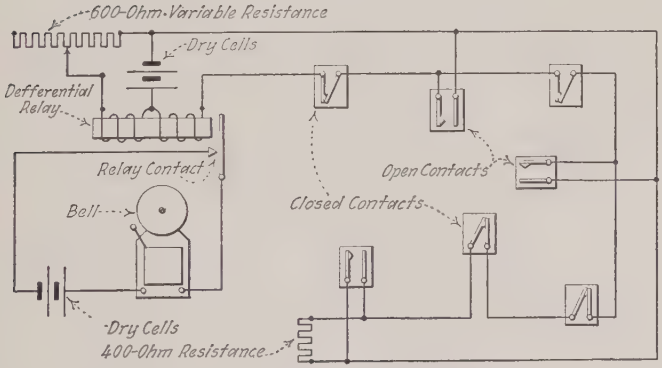


FIG. 112.—A burglar-alarm system designed to confuse an expert. The alarm sounds if the circuit is opened, is closed or if the resistance is varied. The main feature is the relay, which may be a reconstructed telegraph relay. The windings of the two magnets should be connected so that they produce opposite magnetic forces. The end of one of the windings is connected to a variable resistance and the other side to a battery. The second winding has its circuit completed through the alarm circuit in series with a resistance. When the system is properly adjusted, a very sensitive burglar-alarm system results.

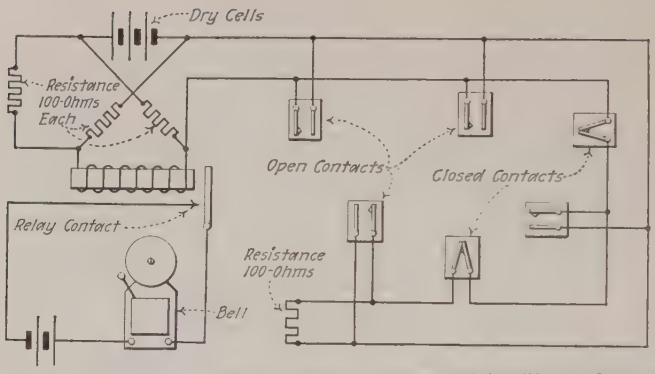


Fig. 113.—A tamper proof burglar-alarm system which will sound an alarm should the system be interfered with. This system is similar to that shown in Fig. 112, with the exception that a single winding relay is used, in this system, insead of a differential relay. The four resistor coils, shown as "100 ohms each" in the drawing, may, instead of being exactly 100 ohms, be of any reasonable resistance, provided they are all of the same resistance. Should the alarm loop become unbalanced, short-circuited or opened, the alarm will be sounded.

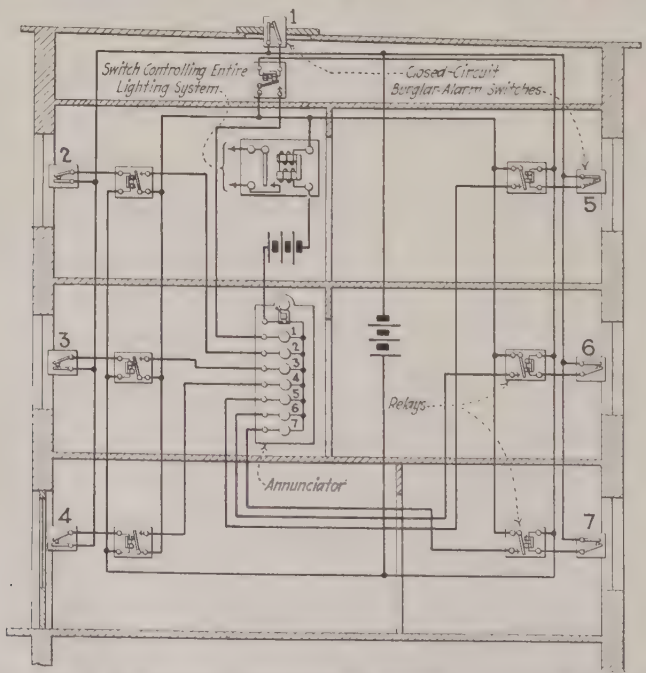


Fig. 114.—A closed-circuit burglar-alarm system. If the circuit is opened at any point, the relays close contactors in the main circuit and operate the alarm bell.

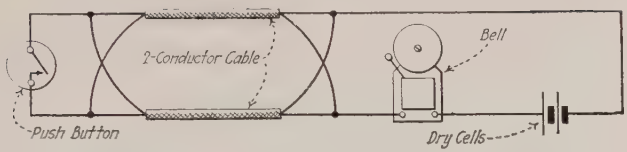


FIG. 115.—Another confusing burglar alarm system. Should the cables be cut the alarm rings. Should the burglar cut one of the conductors, the burglar alarm circuit will still be intact.

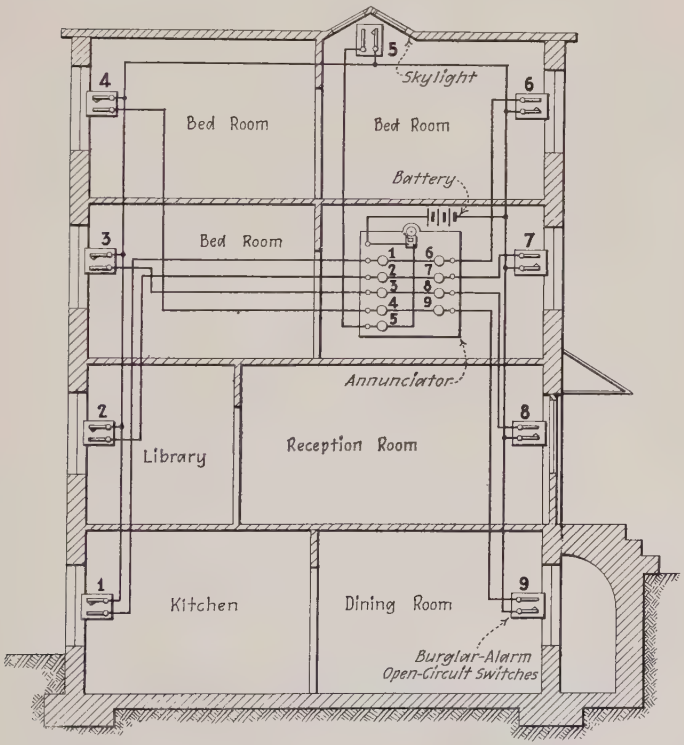
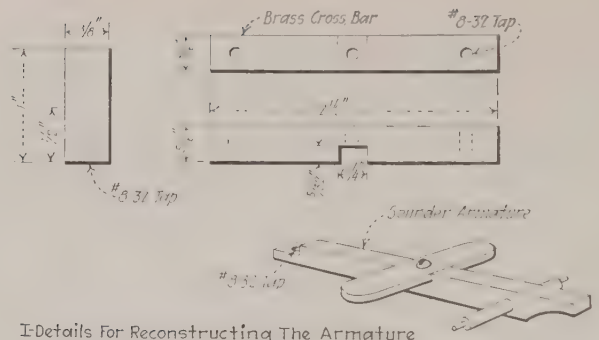


FIG. 116.—Diagram of an open-circuit burglar-alarm system installed in a residence. If the circuit is closed at any point in the system, the burglar alarm sounds.



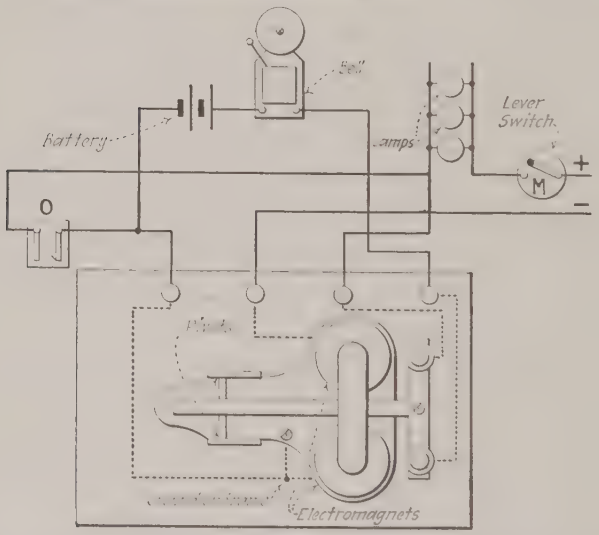


Fig. 117.—An improvised burglar alarm utilizing the *stick relay*. The stick relay is made by reconstructing a telegraph sounder so as to provide it with double contacts. The armature is removed from the sounder and reconstructed as shown in *I*. Two contact posts are mounted on the base of the sounder, which contact with a brass cross bar when the magnets are energized attracting the armature. When switch *M* is closed, but *O* open, no current will flow through the relay, the armature of the sounder being held in its upper position by a spring. If the switch *O* is now closed, by the opening of a door or window, the electromagnets will be energized and the armature pulled down closing a bell circuit and a shunt circuit around the switch *O*. The alarm continues to ring until the switch *M* is opened. This opens the circuit through the electromagnet and releases the armature opening the alarm and shunt circuits. When the switch *M* is again closed, the system is restored to service.

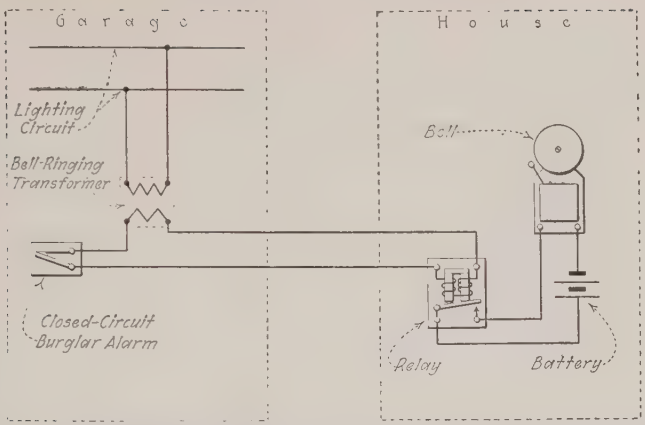


FIG. 118.—A closed-circuit burglar-alarm system using a bell-ringing transformer to energize the closed circuit of the system. Should the power supply be interrupted, the relay will function operating the alarm.

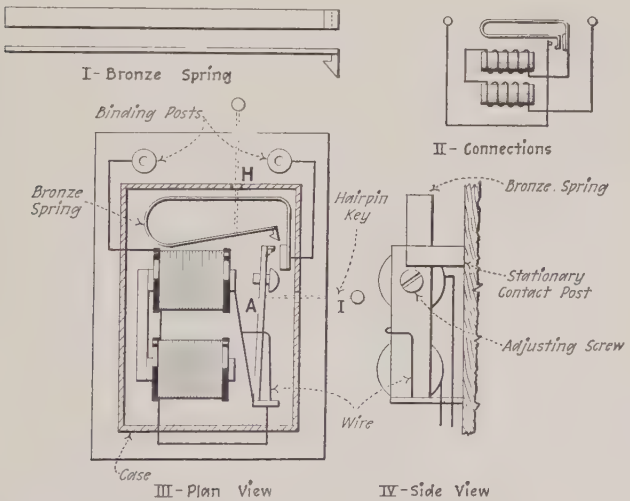


FIG. 119.—A circuit breaker constructed from a buzzer and which can be reset with a piece of wire or a metal hair pin. In operation, an excessive current flowing through the magnet coils attracts the armature *A* toward the magnet. This releases the bronze spring, which flies up and breaks the circuit. The breaker is reset by pushing the spring *S* into place with the hairpin key *H* through the top opening and unset by pushing the hairpin key *I* through the side opening. (*Practical Electrics.*)

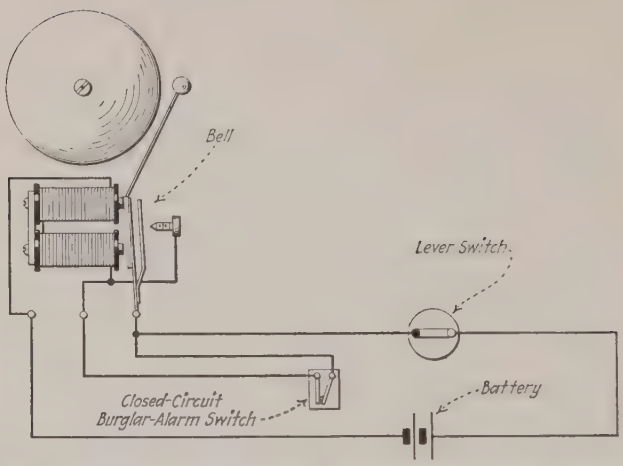


Fig. 120.—One method of connecting a closed-circuit burglar alarm system without using a relay.

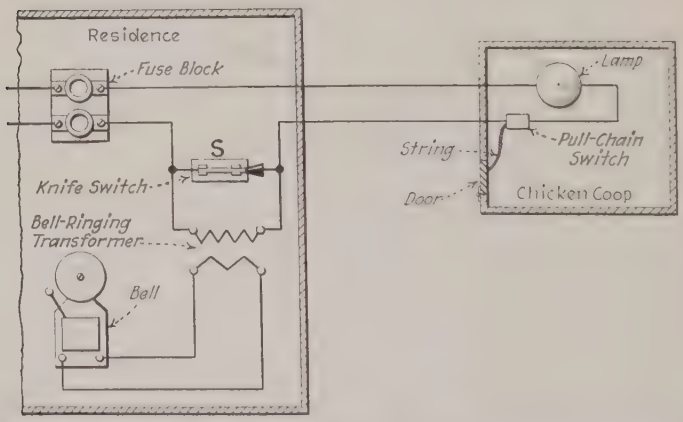
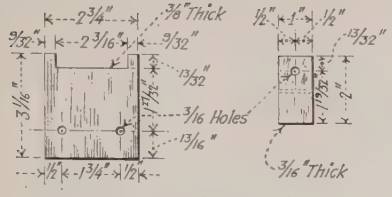
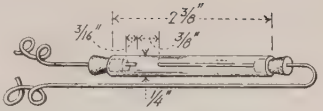


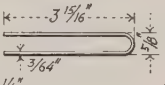
Fig. 121.—A burglar alarm system using a pull-chain switch to actuate the alarm. The pull chain is fastened to the door of the chicken house. The switch *S* in the residence is normally closed, short-circuiting the bell-ringing transformer which is connected in series with a light in the chicken house. With the transformer short-circuited, the lamp can be utilized in the chicken house. To set the alarm at night the switch *S* is opened which connects the transformer into the circuit. When the door is then opened the pull chain switch is operated closing the circuit through the transformer and sounding an alarm.

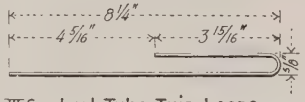


I-Relay Magnet Support

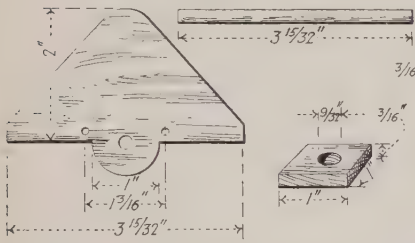


II-Mercury Contact Tube

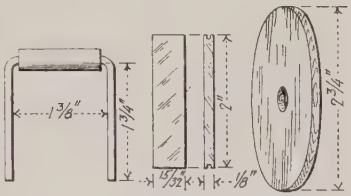




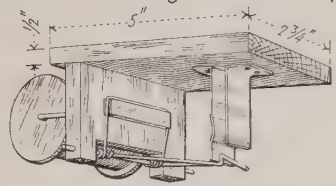
III-Contact Tube Trip Loops



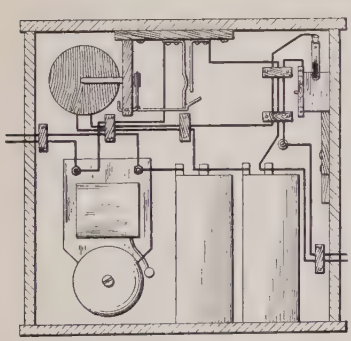
IV-Details Of Mercury Contact Tube Supports



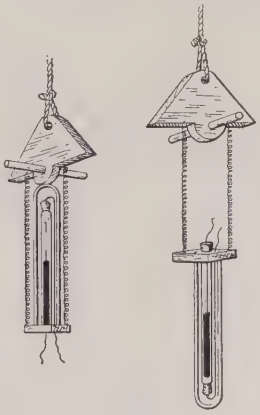
V-Details Of Electromagnet, Core, Armature And Bobbin Discs



VI-Relay-Magnet Set



VII-Complete Arrangement



VIII-Balanced Contact Set

IX-Contact Tripped

FIG. 122.—Details and construction of a sensitive burglar alarm system using a mercury contact tube (which is carefully balanced) as the circuit closing device. The balanced mercury contact tube may be suspended in any location where it is likely to be disturbed by an intruder. (*Practical Electrics*, Nov., 1922.)

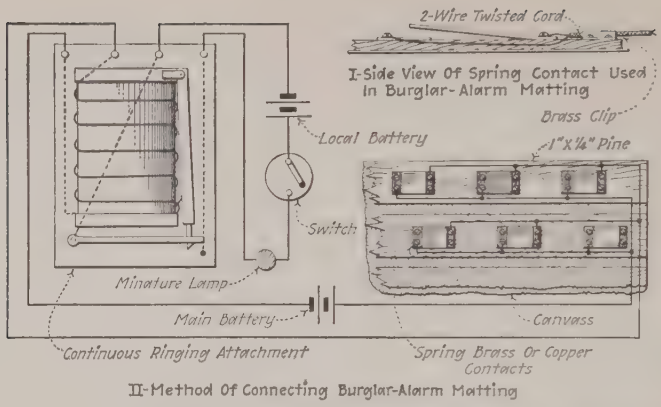


Fig. 123.—Illustrating the construction and connection of burglar-alarm matting. The matting is placed in front of a door so that anyone entering is compelled to step upon it. Stepping on the matting closes the burglar-alarm circuit and lights the lamp—or sounds the alarm. The matting is covered with a rug for appearance and protection.

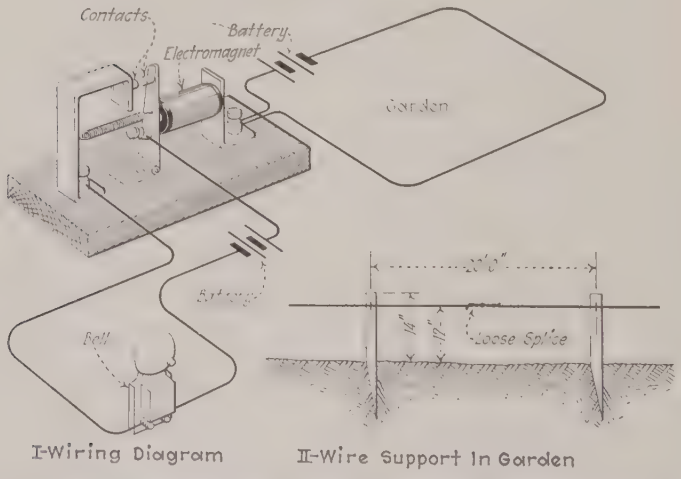


Fig. 124.—A trespasser bell alarm. When the trespasser enters the protected space, his feet will strike the wire which is strung around the boundary of the space; this will open the relay circuit and sound the alarm.

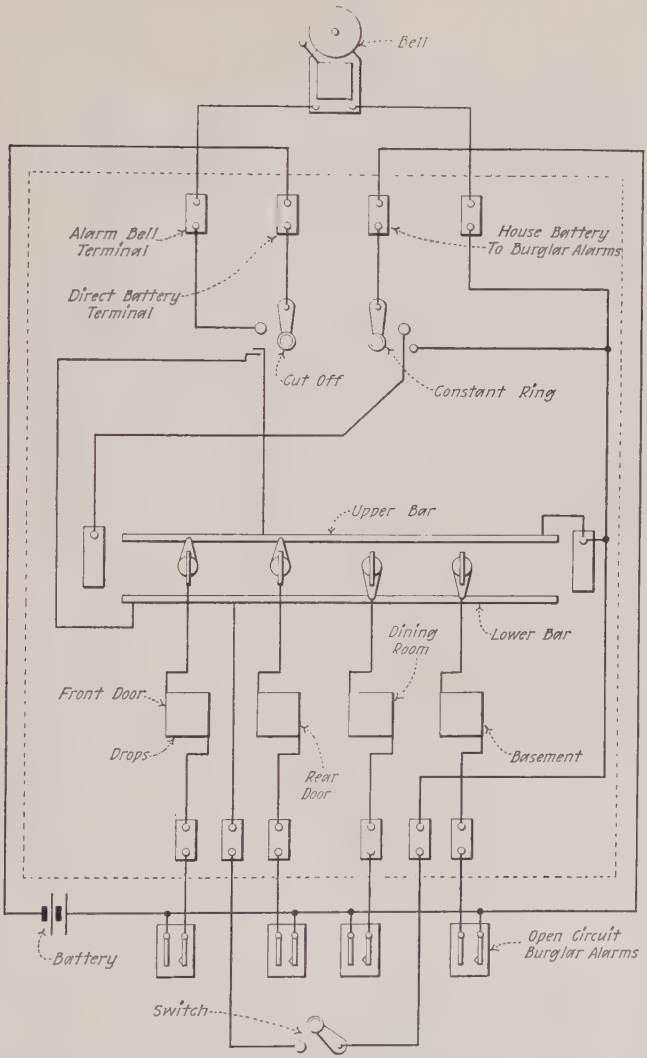


FIG. 125.—Wiring diagram of the connections for a No. 7, Edwards & Co., burglar alarm system.

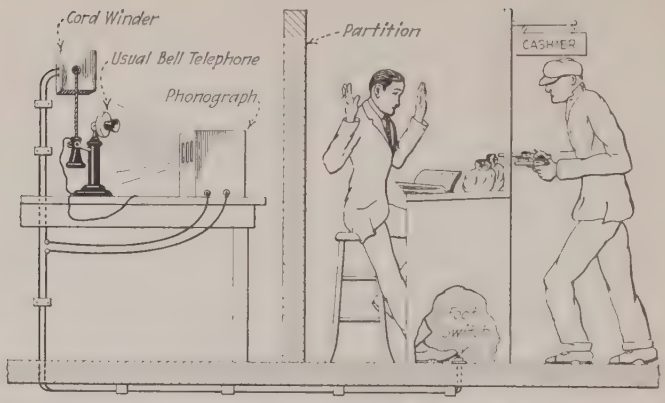


Fig. 126.—A burglar-alarm system where the cashier simply presses a button with his foot, which causes a special device in another room to lift a telephone hook and start a phonograph which give central the call for police.

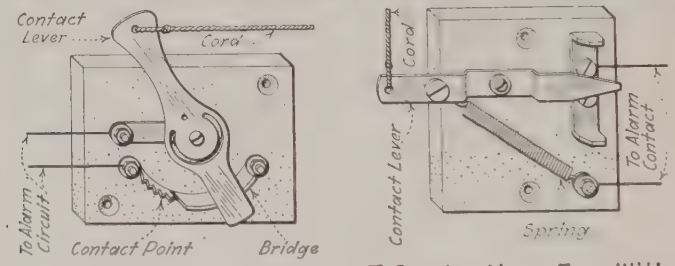


Fig. 127.—Illustrating burglar-alarm traps of two types. The trap shown in *I* is so constructed that when the contact lever is off the bridge it cannot be returned to its original position except by hand. The trap shown in *II* has its contact lever balanced between the two contacts by the use of a string and spring. The strings can be stretched in any room or hallway of the building which is to be protected from the intruders.

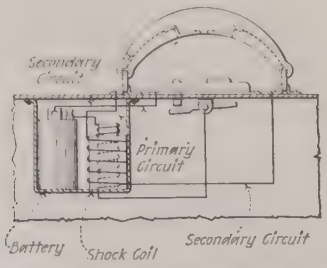


Fig. 128.—A satchel equipped with a battery and shocking coil to guard against having the grip picked up by a thief.

DIVISION 3

HOSPITAL AND HOTEL SIGNALLING

DIVISION 3

HOSPITAL AND HOTEL SIGNALLING

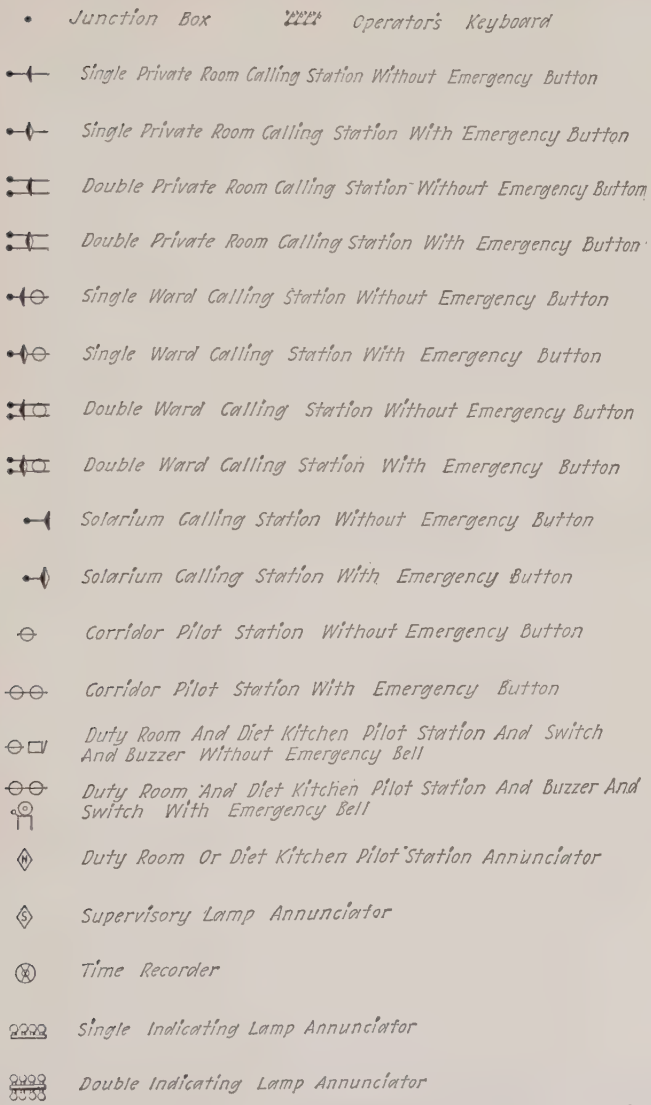

Junction Box
Operator's Keyboard
Single Private Room Calling Station Without Emergency Button
Single Private Room Calling Station With Emergency Button
Double Private Room Calling Station Without Emergency Button
Double Private Room Calling Station With Emergency Button
Single Ward Calling Station Without Emergency Button
Single Ward Calling Station With Emergency Button
Double Ward Calling Station Without Emergency Button
Double Ward Calling Station With Emergency Button
Solarium Calling Station Without Emergency Button
Solarium Calling Station With Emergency Button
Corridor Pilot Station Without Emergency Button
Corridor Pilot Station With Emergency Button
Duty Room And Diet Kitchen Pilot Station And Switch And Buzzer Without Emergency Bell
Duty Room And Diet Kitchen Pilot Station And Buzzer And Switch With Emergency Bell
Duty Room Or Diet Kitchen Pilot Station Annunciator
Supervisory Lamp Annunciator
Time Recorder
Single Indicating Lamp Annunciator
Double Indicating Lamp Annunciator

FIG. 129.—List of symbols used in illustrating the various devices for hospital nurses' and doctors' calling systems.

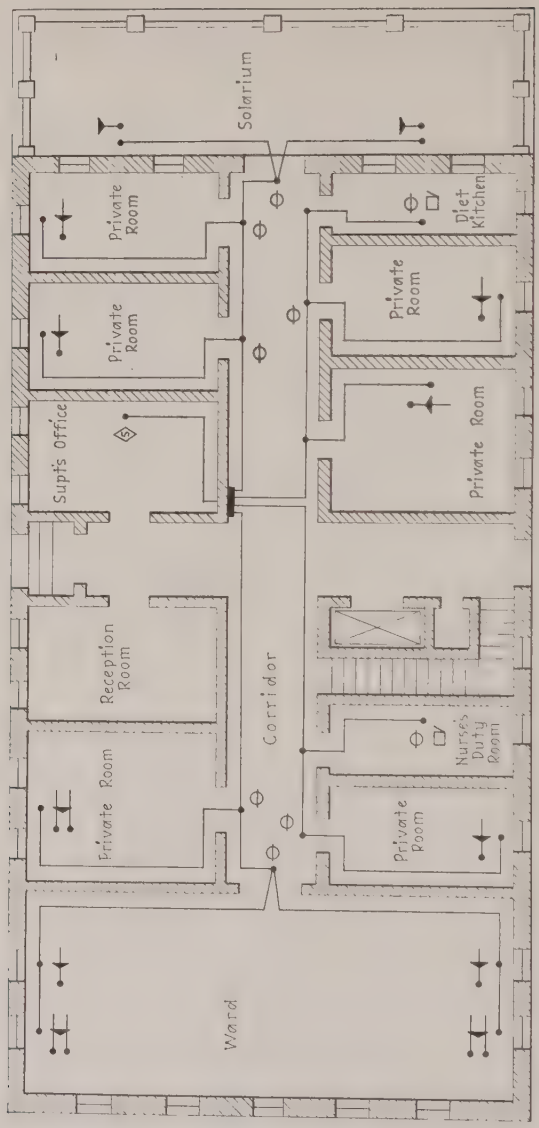


FIG. 130.—A typical conduit layout for a system "A" nurses-call system in a hospital. (HOLTZER-CABOT ELECTRIC Co., *Cat. No.* 4353.)

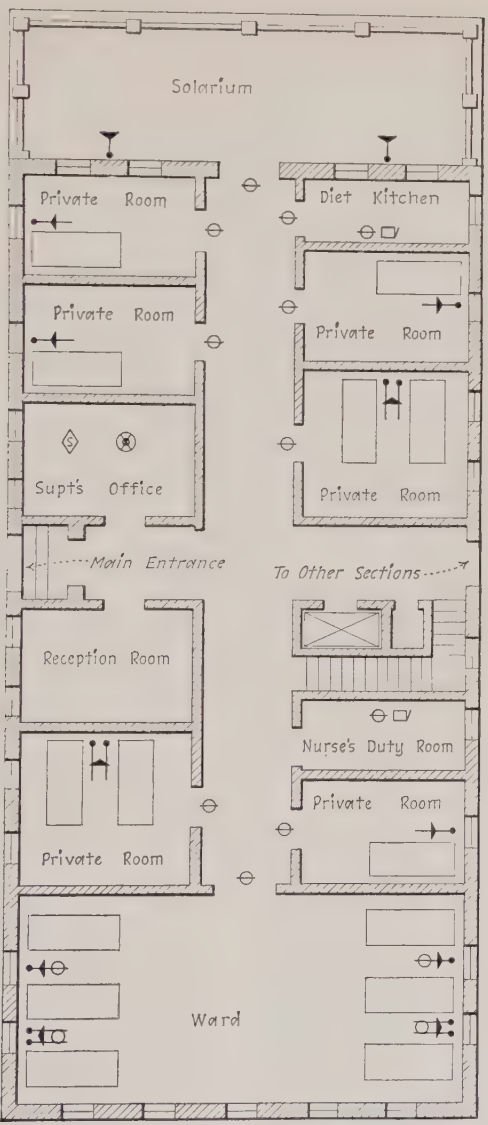


FIG. 131.—Typical floor plan for a system "*E*" hospital signaling system. (HOLTZER-CABOT ELECTRIC CO., *Cat. No.* 4353.)

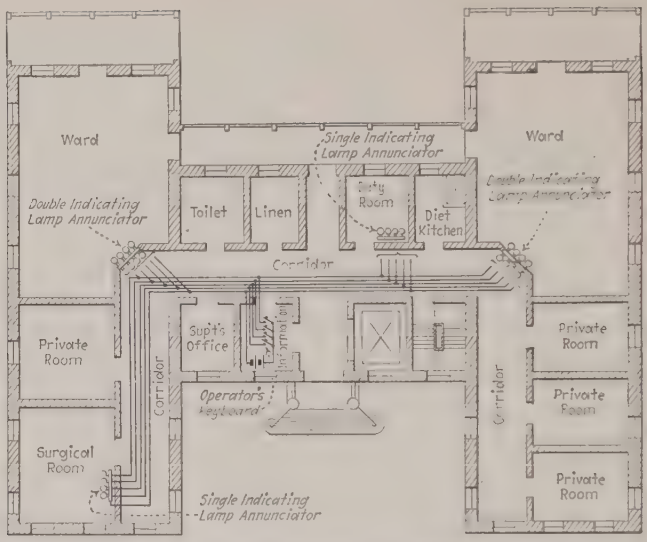


Fig. 132.—Floor plan and wiring diagram of a Deveau hospital doctor's-call system

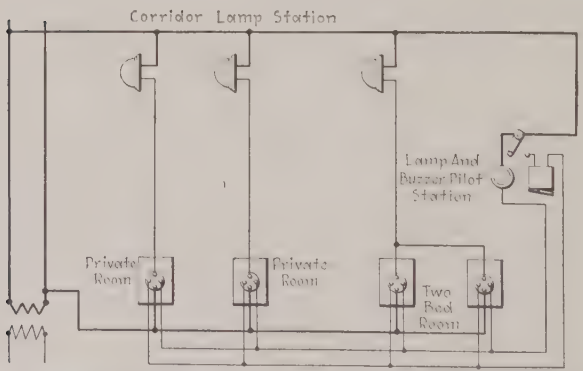


Fig. 133.—Typical wiring diagram of a system "*A*" hospital signaling circuit. A patient in a room pressing a locking button, lights the pilot lamps and sounds the buzzer in the nurse's duty rooms and the diet kitchen. (Holtzer-Cabot Electric Co., *Cat. No.* 4353.)

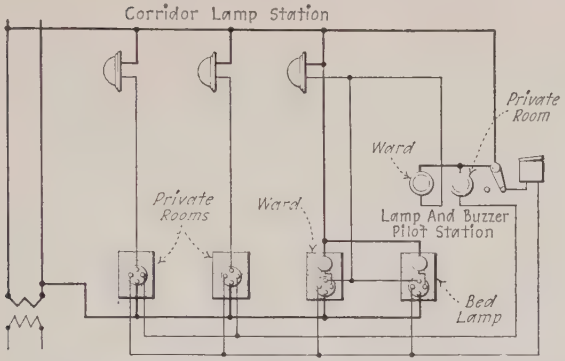


FIG. 134.—A typical wiring diagram of a system "*B*" hospital signalling circuit. A patient pressing a locking button lights the lamp over the door in the corridor, lights the private room or the ward pilot, as the case may be, and sounds the buzzers in the duty room and diet kitchen. When a call is made from a ward, a light also appears over the bed of the patient calling. The nurse hearing the buzzer, notes by the pilot lamp whether the call is from a ward or a private room, looking along the hall she observes over which door the lamp is burning.

When she arrives at a patient's bedside in a private room, she releases the locking button which extinguishes the corridor lamp, and if no other private room call exists, the private room pilot lamps are also extinguished. If the call is from a ward and no other call exists in the ward, the releasing of the button extinguishes the signal over the bed, the corridor lamp, and the pilot lamps of that ward. (HOLTZER-CABOT ELECTRIC CO., *Cat. No.* 4353.)

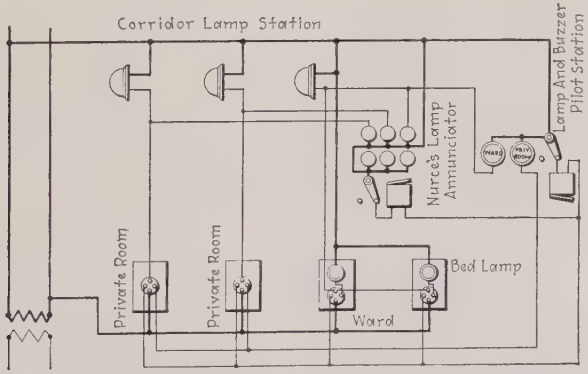


FIG. 135.—A typical wiring diagram of a system "*C*" nurses calling system for a hospital. This system differs from the "*A*" and "*B*" systems in that the nurse is able to locate the exact room, from which the call is made, directly from the duty room. (HOLTZER-CABOT ELECTRIC CO., *Cat. No.* 4353.)

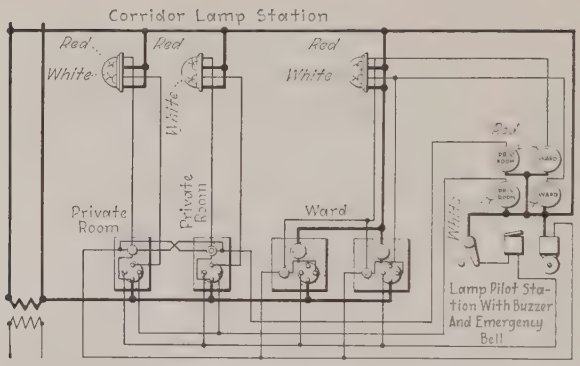


Fig. 136.—A typical wiring diagram of a system "*D*" hospital nurses calling circuit. In this system, should the nurse find the patient critically ill and needing a doctor's assistance quickly, she presses the emergency button in the wall plate which lights the emergency lamp outside the door and also sounds bells in the duty room and diet kitchen continuously. This system is usually installed in private rooms and wards where dangerous cases are placed. (Holtzer-Cabot Electric Co., *Cat. No.* 4353.)

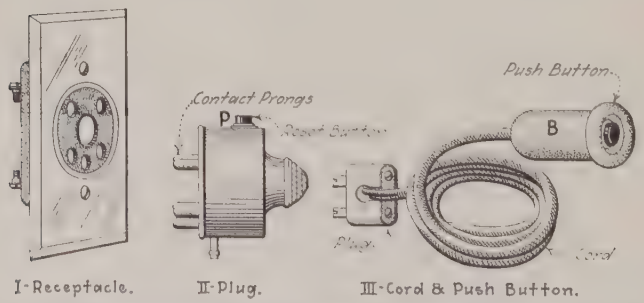


Fig. 137.—The three parts which constitute the call station of a Chicago Signal Co.'s nurses call system. In *I* is shown the *receptacle* which is mounted flush in a suitable conduit box. In *II* is the *Plug* which plugs into the receptacle and contains the contact making mechanism and pilot light. The cord and push button is illustrated in *III*. The construction and the circuit connections of the plug are shown in Fig. 138. (Chicago Signal Co.)

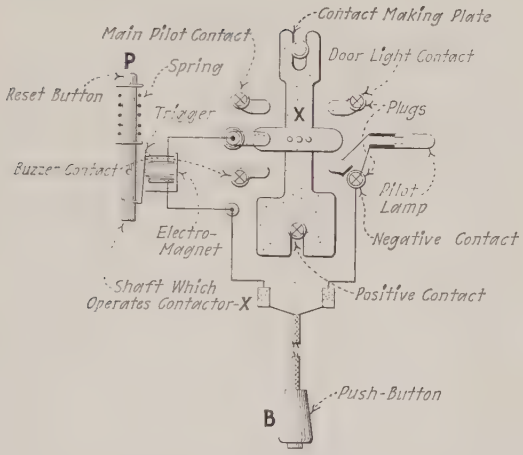


Fig. 138.—Construction and connections of a patient's station of a Chicago hospital signal station. See also Fig. 137.

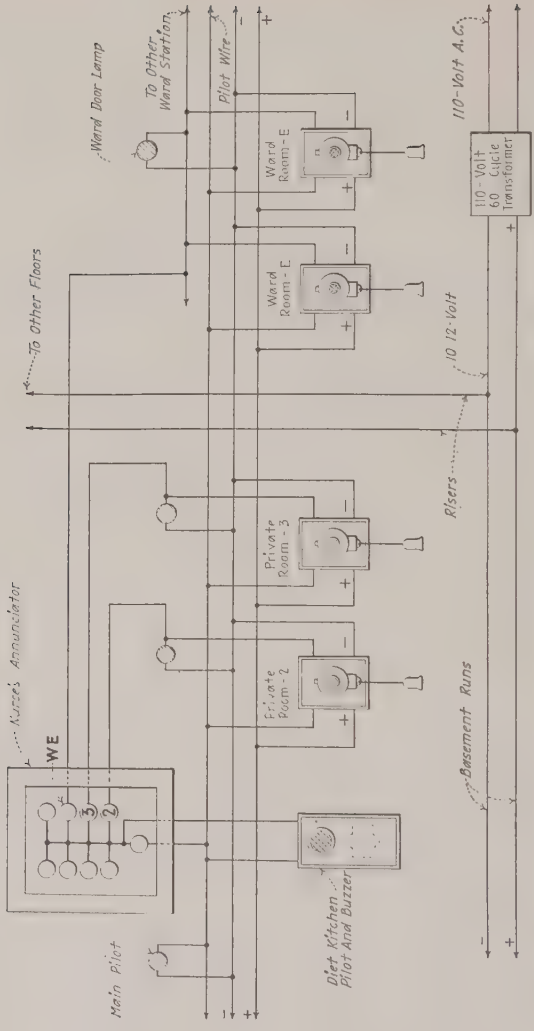


FIG. 139.—Wiring diagram of a Chicago silent-call hospital signal system, constant-buzzer type. (CHICAGO SIGNAL CO., Chicago, Ill.)

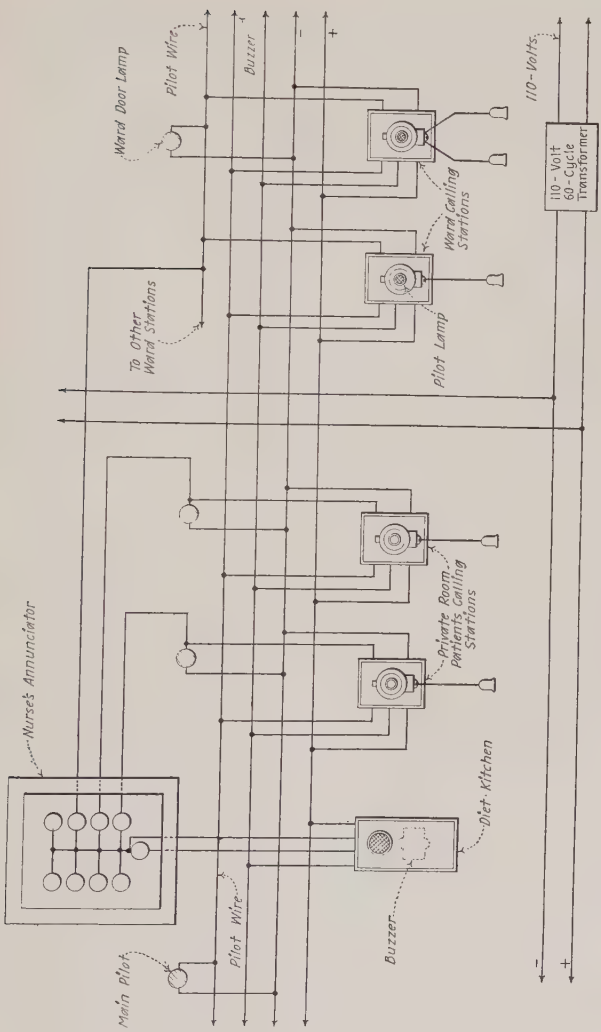


FIG. 140.—Wiring diagram of a Chicago silent-call hospital signal system, momentary-buzzer type. (CHICAGO SIGNAL CO., Chicago, Ill.)

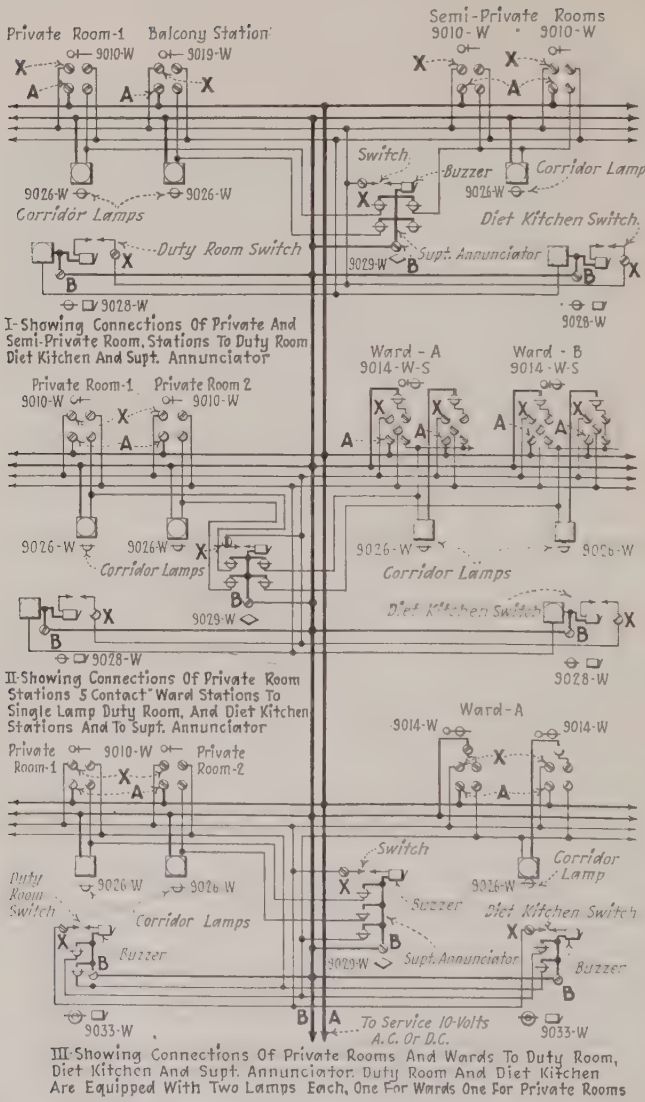


Fig. 141.—Wiring diagram of a Connecticut automatic hospital signal system. The wire sizes which should be used are as follows: From transformer to distribution point, No. 12 B. & S.; from distribution point to local feeders, No. 14 B. & S.; all other wires, No. 16 B. & S.; all wires to be approved National Electrical Code rubber-covered, coded braid. ("Connecticut Automatic Signal System for Hospitals," *Bulletin* 400.)

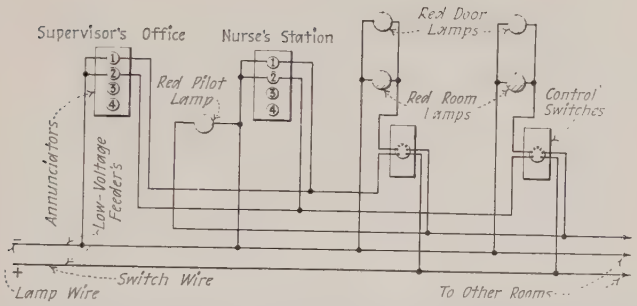


FIG. 142.—Wiring diagram for a No. 101 Hartung hospital silent-call signal system, having red room-light, red door-light, red pilot-light and nurse's and supervisor's lamp annunciators. (HARTUNG HOSPITAL SILENT CALL SIGNAL SYSTEM, *Bull. No.* 2.)

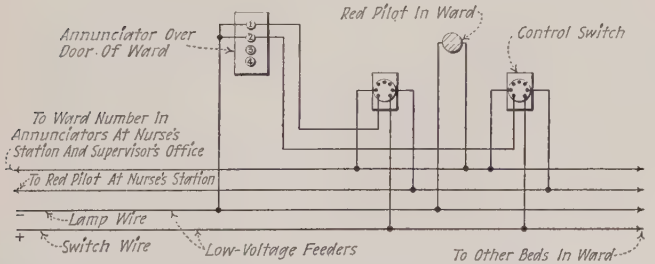

Red Pilot In Ward
Annunciator Over Door Of Ward
Control Switch
To Ward Number In Annunciators At Nurse's Station And Supervisor's Office
To Red Pilot At Nurse's Station
Lamp Wire
Switch Wire
Low-Voltage Feeders
To Other Beds In Ward

FIG. 143.—Wiring diagram for a Hartung hospital silent-call signal system No. 101A. Used in combination with the No. 101 calling station, and designed for wards having four or more calling stations and with a red pilot-light common to all stations in the ward and a two-face lamp annunciator over the door of the ward. (HARTUNG HOSPITAL SILENT CALL SIGNAL SYSTEM, *Bull. No.* 2.)

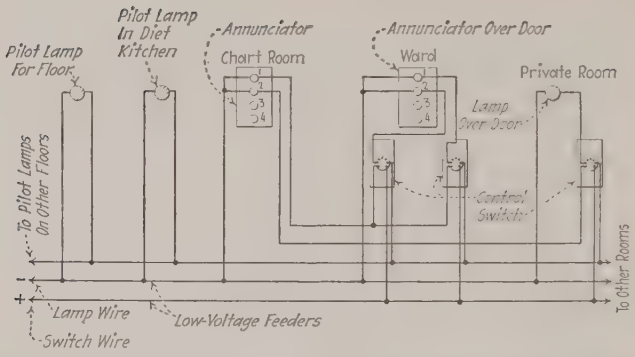


Fig. 144.—Wiring diagram for a No. 101B Hartung hospital silent-call signal system installed in combination with a No. 101 calling station. This arrangement has red door lights for rooms having three or less calling stations, a red pilot light, a lamp annunciator in the chart room and a two-face lamp annunciator over the doors of wards which have four or more calling stations. It is provided with a floor-control pilot-light. (Hartung Hospital Silent Call System, *Bull. No.* 2.)

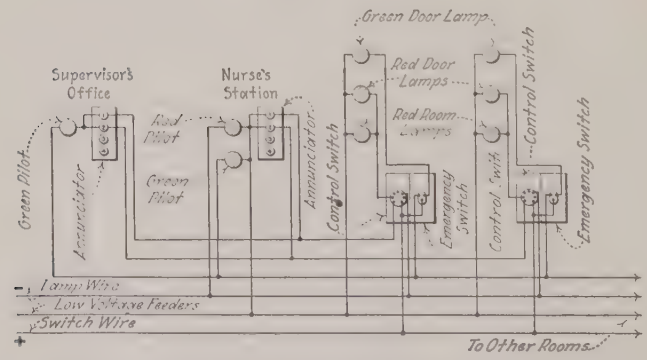


Fig. 145.—Wiring diagram for a No. 102 Hartung hospital silent-call signal system, installed in combination with a No. 102 calling station which has a red room-light, a red pilot-light, and nurse's and supervisor's lamp annunciators. This also provides emergency calling, with green door-lights and green pilot-lights. (Hartung Hospital Silent Call Signal System, *Bull. No.* 2.)

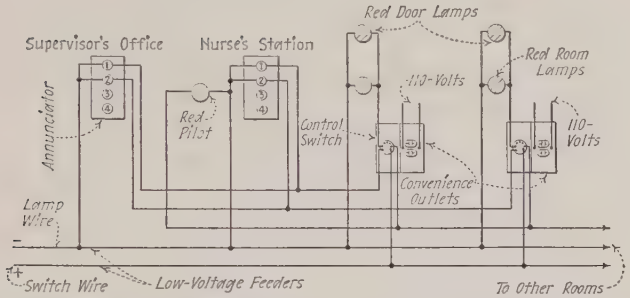


FIG. 146.—Wiring diagram for a No. 103 Hartung hospital silent-call signal system, installed in combination with a No. 103 calling station having a red room-light, a red pilot-light, and nurse's and supervisor's lamp annunciators and a plug receptacle for the examination lamp. (HARTUNG HOSPITAL SILENT CALL SIGNAL SYSTEM, *Bull. No.* 2.)

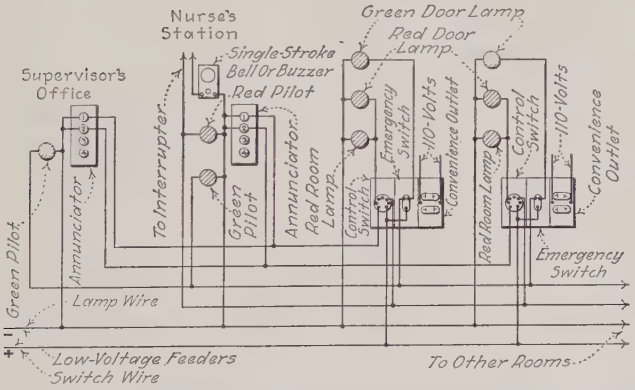


FIG. 147.—Wiring diagram for a No. 104 Hartung hospital silent-call signal system installed in combination with a No. 104 calling station which has a red room-light, a red door-light, and a red pilot-light, and nurse's and supervisor's lamp annunciators and emergency calling with a green door-light and pilot-lights. A plug receptacle, for the examination lamp, is provided. There is a bell or buzzer for night service. (HARTUNG HOSPITAL SILENT CALL SIGNAL SYSTEM, *Bull. No.* 2.)

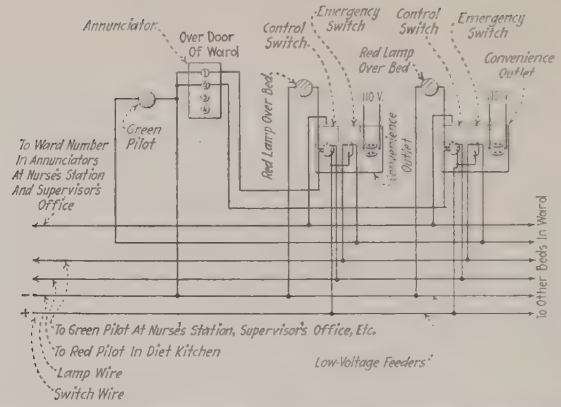


Fig. 148.—Wiring diagram for a No. 104A Hartung hospital silent-call signal system, installed in combination with a No. 104 calling station. This arrangement is for wards having four or more calling stations. It is provided with individual red-lights for each bed and two face-lamp annunciators over each door of the ward. Emergency signaling is provided by a green light over the door and a green pilot-light. A plug receptable for the examination lamp is also provided. (Hartung Hospital Silent Call Signal System, *Bull. No.* 2.)

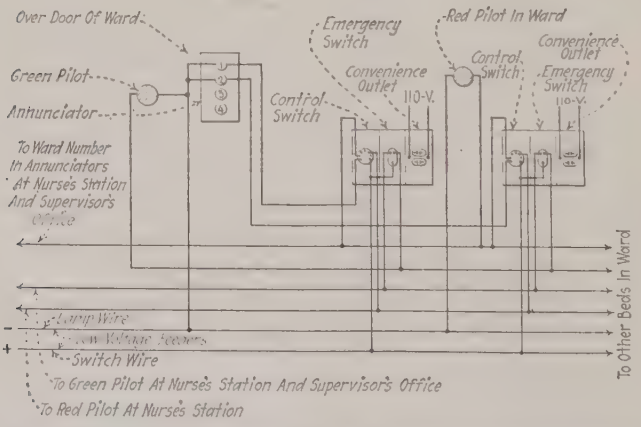


Fig. 149.—Wiring diagram for a No. 104B Hartung hospital silent-call signal system in combination with a No. 104B calling station, for wards having four of more calling stations. It has a red pilot-light common to all stations in the ward. A two-face lamp annunciator is installed over the door of the ward. The emergency calling signal is a green light over the door and a green pilot-light. (Hartung Hospital Silent Call Signal System, *Bull. No.* 2.)

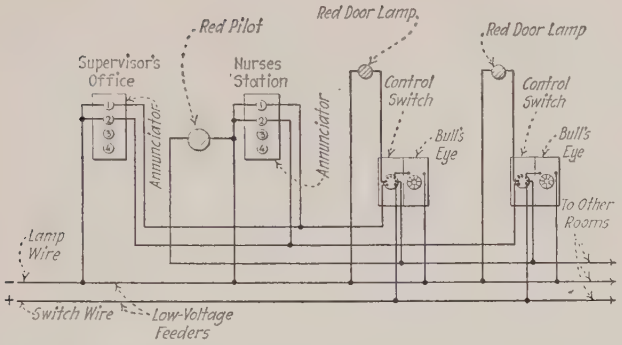


FIG. 150.—Wiring diagram for a No. 109 Hartung hospital silent-call system in combination with No. 109 calling station which has a red bull's eye, a red door-light, a red pilot-light, and nurse's and supervisor's lamp annunciators. (HARTUNG HOSPITAL SILENT CALL SIGNAL SYSTEMS, *Bull. No.* 2.)

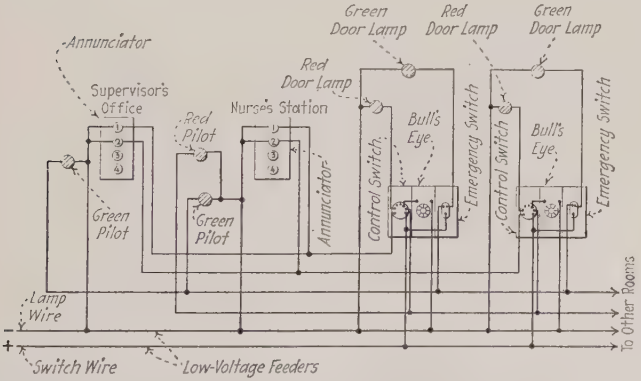


FIG. 151.—Wiring diagram for a No. 110 Hartung hospital signal system in combination with a No. 110 calling station which has a red bull's eye, a red door-light, a red pilot-light, and nurse's and supervisor's lamp annunciatotr. Emergency calling is provided by a green door-light and a green pilot-lighs. (HARTUNG HOSPITAL SILENT CALL SIGNAL SYSTEM, *Bull. No.* 2.)

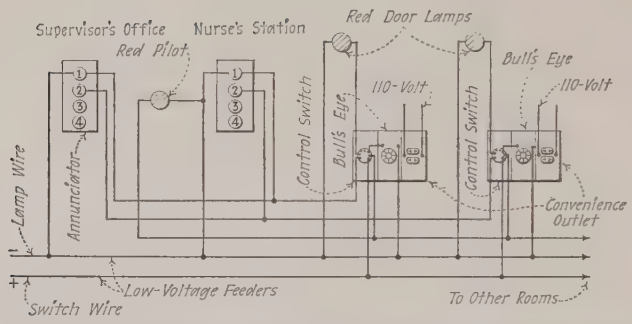


Fig. 152.—Wiring diagram for a No. 111 Hartung hospital signal system in combination with a No. 111 calling station which has a red bull's eye, a red door-light, a red pilot-light, and nurse's and supervisor's lamp annunciators. (Hartung Hospital Silent Call Signal System, *Bull. No.* 2.)

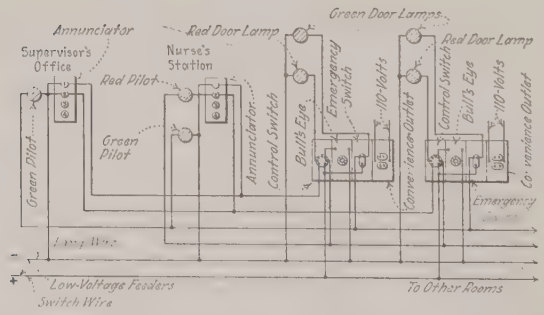


Fig. 153.—Wiring diagram for a No. 112 Hartung hospital silent-call signal system, installed in combination with a No. 112 calling station which has a red bull's eye, a red door-light, a red pilot-light, and nurse's and supervisor's lamp annunciators. Emergency calling is provided by a green door-light and a green pilot-light. (Hartung Hospital Silent Call Signal System, *Bull. No.* 2.)

DIVISION 4

TIME AND PROGRAM CLOCK CIRCUITS

TIME AND PROGRAM CLOCK CIRCUITS

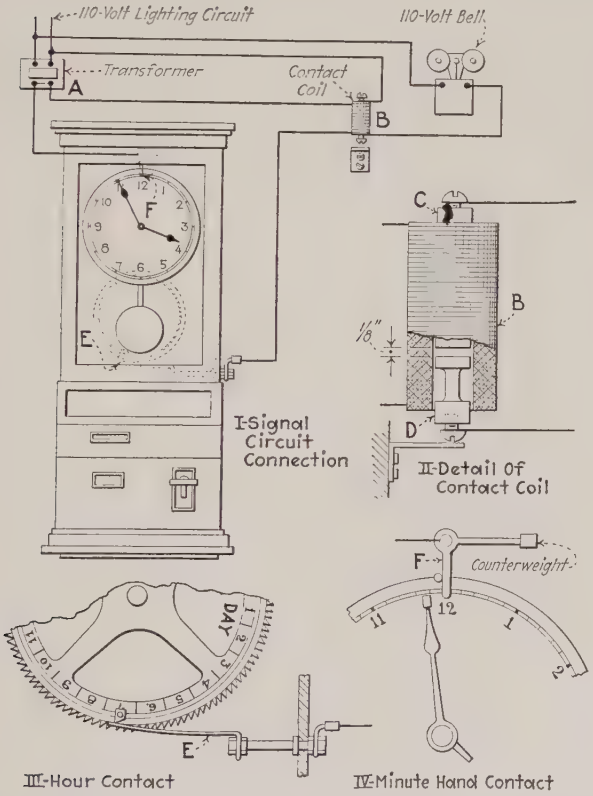


FIG. 154.—An improvised automatic time signal. A 50-watt potential transformer, *A*, was connected to the lighting service in the plant. A 110-volt bell and also the contacts of a solenoid coil *B* were connected across the lighting circuit. The secondary voltage of the transformer, which was about 10 volts, was connected across the solenoid coil *B*. The time clock, which was equipped with a brass wheel (Fig. *III*) about 10 in. in diameter, was provided with lugs which closed an electric circuit through a second contact making device (Fig. *IV*) attached to the minute hand of the clock. With this arrangement, when the circuit to the coil *B* is closed, by the contacts *E* and *F* on the clock, the core *D* is drawn up against the stationary core, *C*, thus closing the signal circuit and sounding the gong.

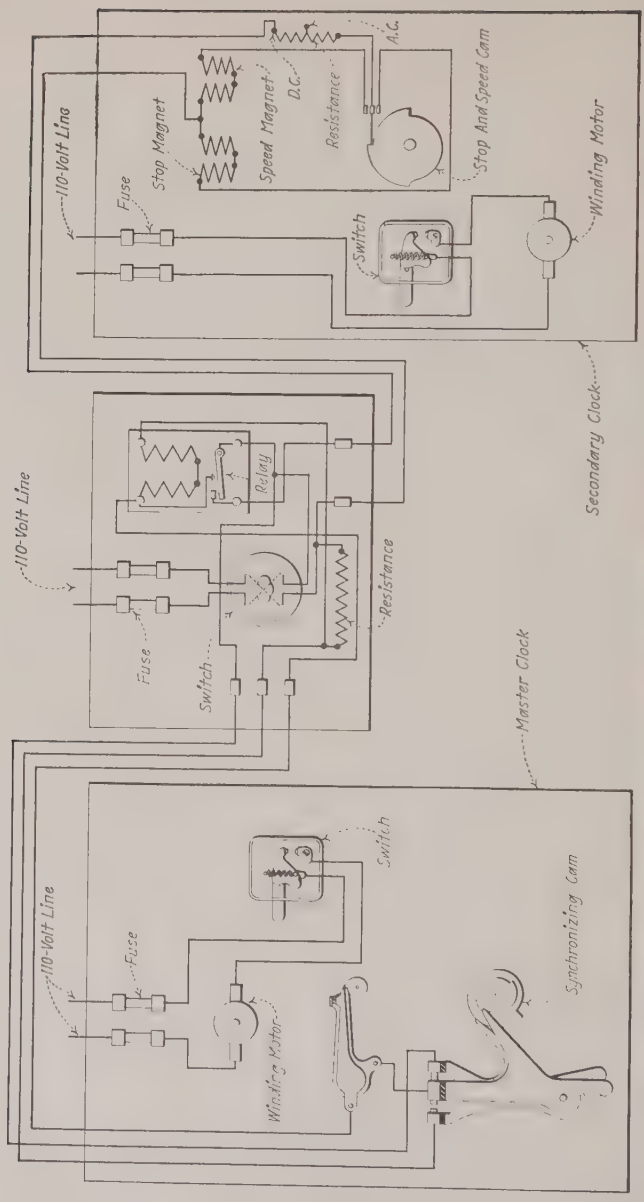
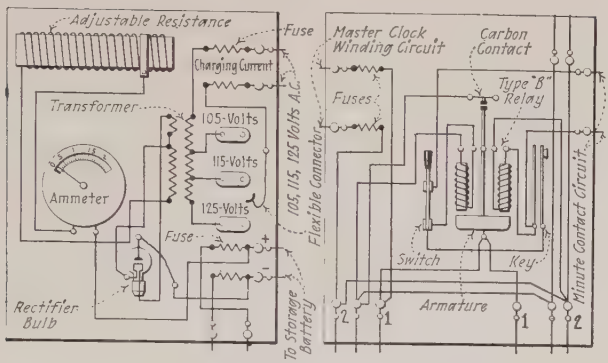
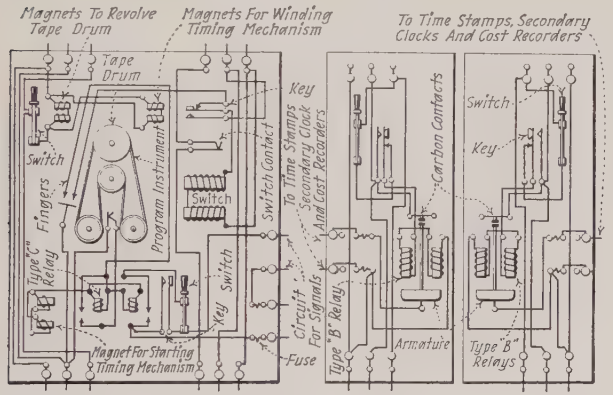


Fig. 155.—Wiring diagram for an electric synchronized clock system. (The International Time Recording Company.)





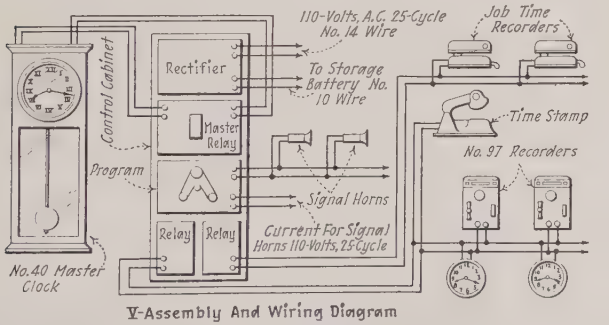


FIG. 156.—Wiring diagram of a Stromberg electric clock system. The master clock controls job-time recorders, time stamps, *in* and *out* recorders and secondary clocks. A program system is also provided. (STROMBERG ELECTRIC CO.)

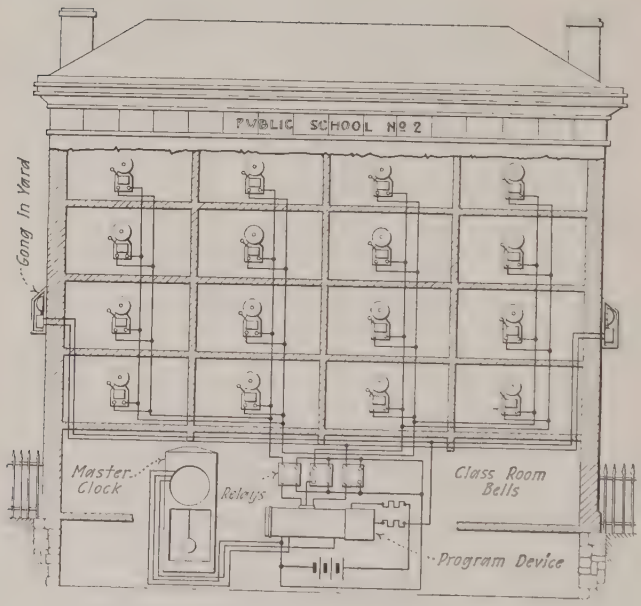


Fig. 157.—Wiring plan for a program bell system.

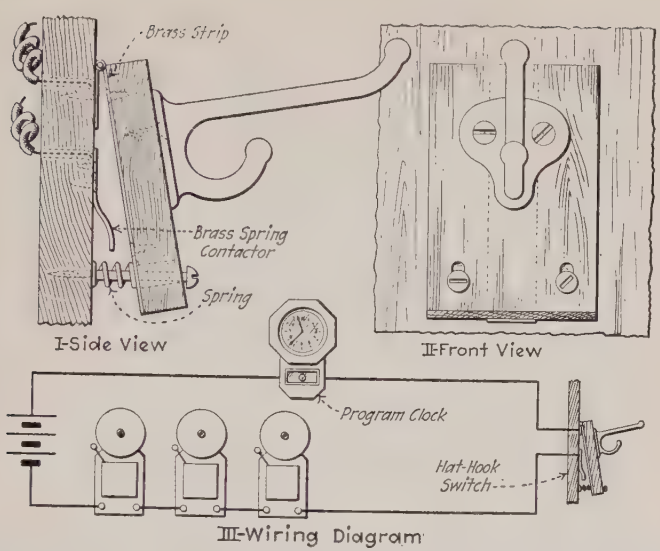


FIG. 158.—Hat-hook switch connected in the bell ringing circuit of a clock system of a school. The hat-hook switch was located in the principal's office. This scheme prevented the ringing of the bells during the night and when school was closed since the principal was always at the school during school sessions. (*Popular Mechanics.*)

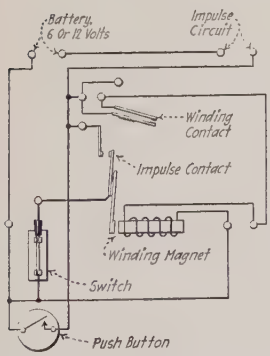


FIG. 159.—Wiring diagram of the winding and impulse circuit of a Type-*A* clock movement of an International Electric Master clock. (INTERNATIONAL ELECTRIC TIME SYSTEMS.)

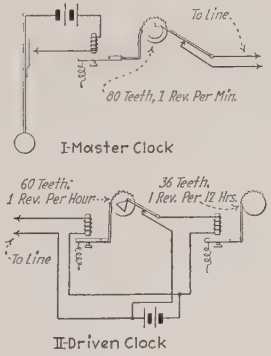


FIG. 160.—Illustration showing the circuit used in converting an old pendulum clock into a master electric clock. This master clock operates a number of secondary clocks as shown in *II*.

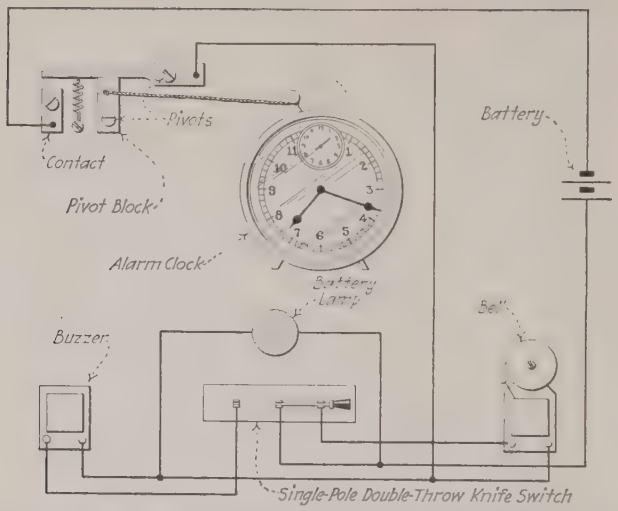


Fig. 161.—Arrangement for an alarm clock signal, which can be set by a double throw switch, so that either a buzzer or a bell may be operated according to the way in which the switch is thrown.

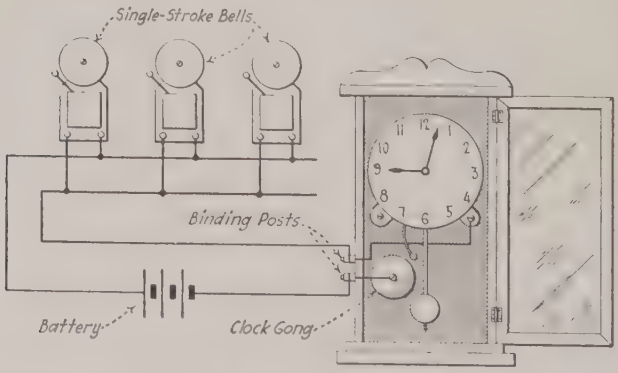


Fig. 162.—A clock which rings the hour at any distant point by closing an electric contact between its bell and hammer.

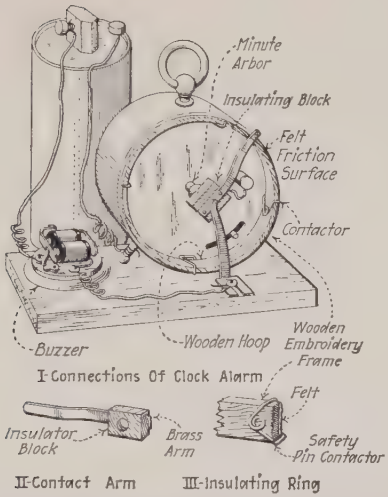


FIG. 163.—An alarm clock equipped with an improvised contact-making arrangement which will close an alarm circuit at any desired time.

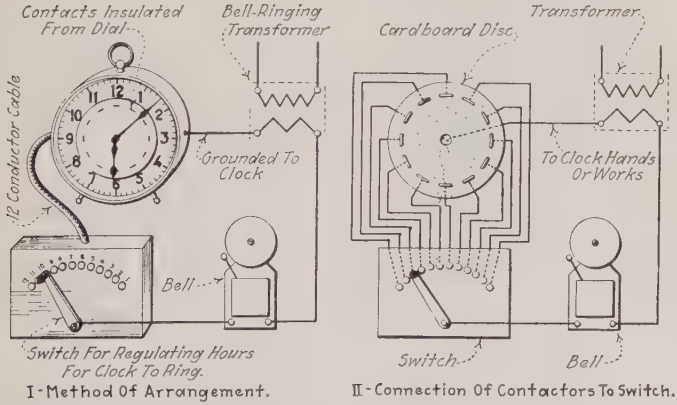


FIG. 164.—An electric alarm bell. A special dial is constructed from a cardboard disc which is fitted with the proper contacts. A homemade switch is used to regulate the hour at which the alarm should ring.

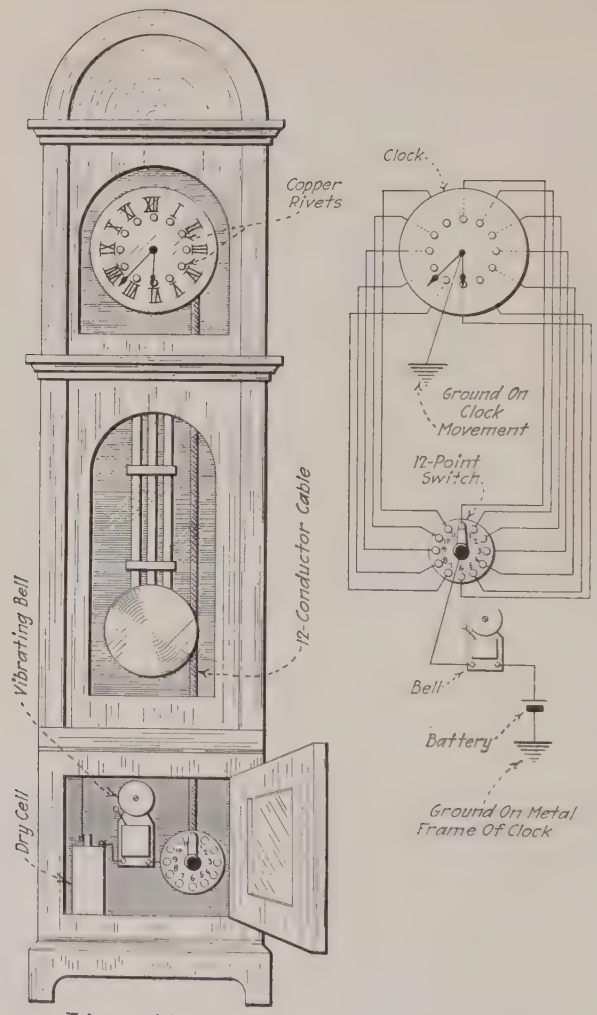


Fig. 165.—Converting a grandfather's clock into an efficient alarm clock without changing its outward appearance. The face of the clock, if mounted on metal, is removed and mounted on a wooden back, to provide insulation. Round-head copper rivets are mounted in holes and lead wires are soldered to their backs. A small very flexible spring is soldered to the back of the hour hand so that it will contact with the rivet heads as the hand rotates. To set the alarm, for example, at 6 o'clock, turn the switch arm to the number "6." Then, when the hour-hand spring makes contact with the "6" rivet on the dial, the bell will ring until the switch arm is shifted or until the hand has moved away from the rivet. (*Popular Science Monthly.*)

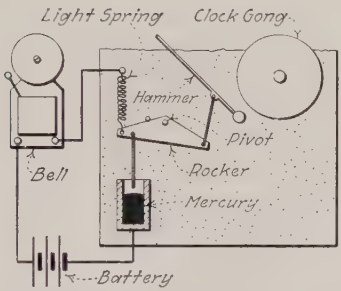


FIG. 166.—Illustration of a mercury switch rigged up to ring an extension bell whenever a clock strikes the hour and at intermediate instants. The rocker is attached to and operated by the clock mechanism. The feature of the device is the mercury contactor or circuit-closing device which operates positively with a very small applied force.

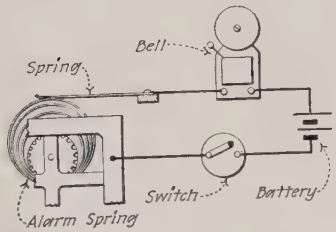


FIG. 167.—An alarm which notifies when a clock requires winding. The spring contactor closes an electric alarm circuit when the spring of the clock unwinds.

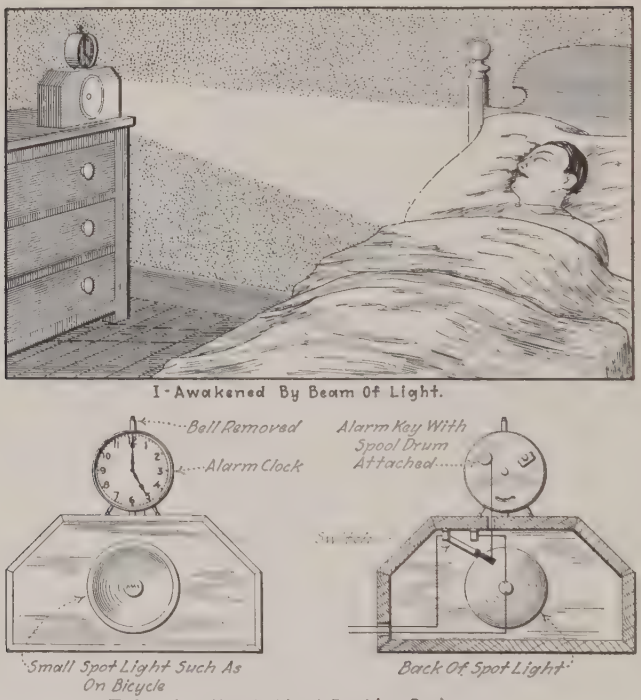

I-Awakened By Beam Of Light.
Bell Removed
Alarm Clock
Alarm Key With Spool Drum Attached
Small Spot Light Such As On Bicycle
Back Of Spot Light
II-Construction Of Light Flashing Device.

Fig. 168.—A noiseless electric alarm clock. The flashing of a beam of light in the face of the sleeper is assumed to cause him to awaken. (*Electrical Experimenter*, June, 1917.)

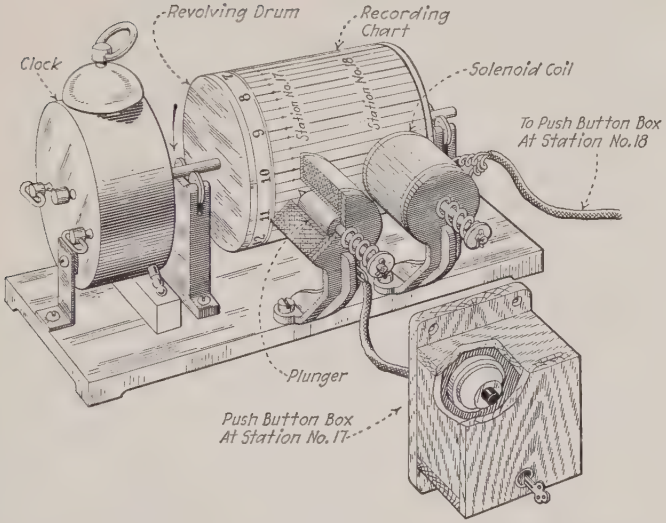
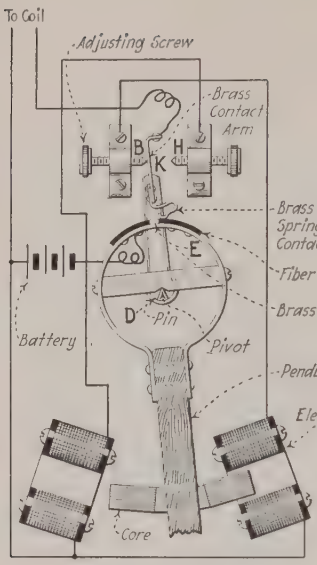
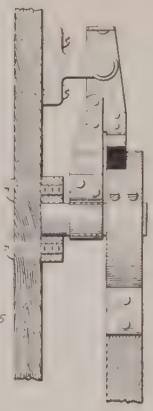


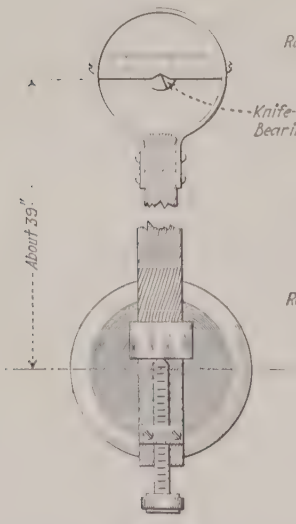
Fig. 169.—An improvised watchman's round-recording instrument that proved very practical when it was found necessary to add to an existing system. (*Popular Mechanics.*)



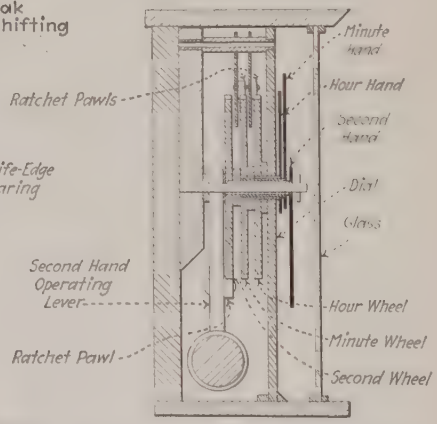
I-The Electric Make-And-Break Of The Clock Showing The Shifting Of The Contact



III-Side View Of The Electric Clock's Connections At Top Of Pendulum



II-Construction Of The Pendulum, Its Knife-Edge Suspension And Adjusting Screw



IV-Section Through Clock Showing Ratchet Arrangement

Fig. 170.

Fig. 170.—Details of the construction of an electric master clock and a secondary clock operated by the master clock. In *I* is shown the complete electrical circuit of the master clock. The pendulum swings on a knife-edged pivot. The movement of the pendulum is effected by the electromagnets which are energized through contacts *H* and *B*. The brass contact arm *K* is supported, free to move, on pin *D*, and has attached to it a spring contact which bears on the pendulum. The brass contact arm is shifted due to the friction of the spring contact against the pendulum ring, which also makes and breaks the circuit through the secondary clocks (*IV* and Fig. 171) through contact *E*. The secondary clock is shown in *IV* and in Fig. 171. (*Practical Electrics*, Feb., 1922.)

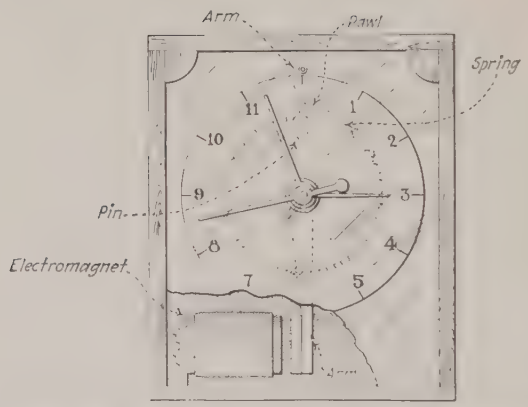


Fig. 171.—Front view of the clock dial of Fig. 170 showing ratchet wheel and pawl.

DIVISION 5

AUTOCALL SIGNALLING CIRCUITS

DIVISION 5

AUTOCALL SIGNALLING CIRCUITS

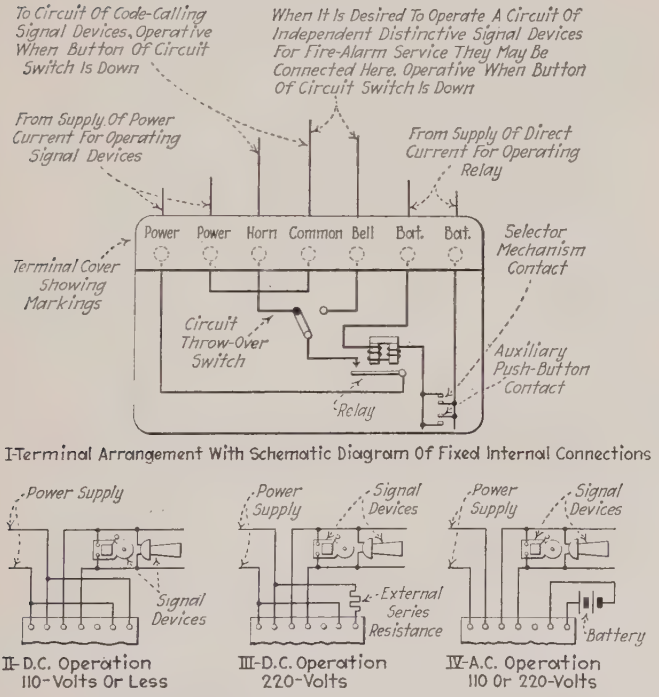

To Circuit Of Code-Calling Signal Devices, Operative When Button Of Circuit Switch Is Down
When It Is Desired To Operate A Circuit Of Independent Distinctive Signal Devices For Fire-Alarm Service They May Be Connected Here, Operative When Button Of Circuit Switch Is Down
From Supply Of Power Current For Operating Signal Devices
From Supply Of Direct Current For Operating Relay
Power
Power
Horn
Common
Bell
Bat.
Bat.
Selector Mechanism Contact
Terminal Cover Showing Markings
Circuit Throw-Over Switch
Auxiliary Push-Button Contact
Relay
I-Terminal Arrangement With Schematic Diagram Of Fixed Internal Connections
Power Supply
Signal Devices
II-D.C. Operation 110-Volts Or Less
Power Supply
Signal Devices
External Series Resistance
III-D.C. Operation 220-Volts
Power Supply
Signal Devices
Battery
IV-A.C. Operation 110 Or 220-Volts

FIG. 172.—Wiring diagrams of transmitters used on factory signal systems showing the variations in the wiring for different voltages. (*Klaxon Co.*, Newark, N. J.)

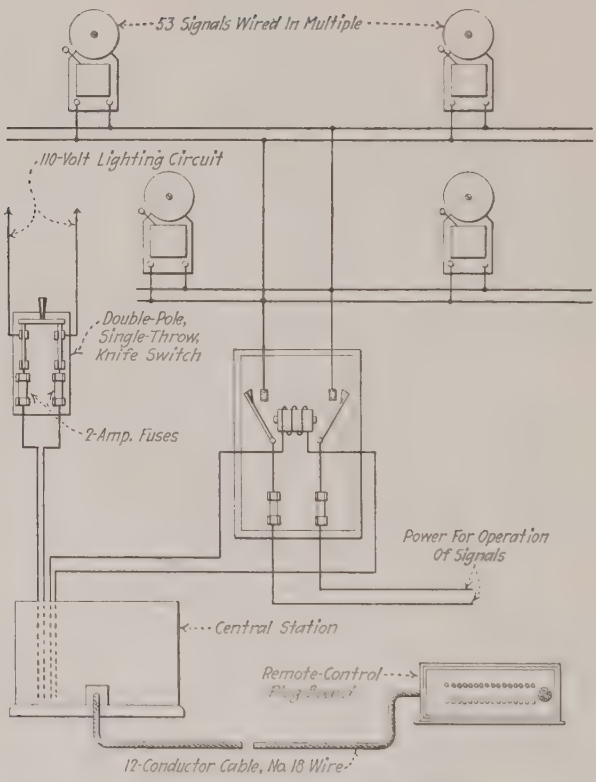


Fig. 173.—Wiring diagram of an industrial signal system for use on alternating-current circuits. (*The Autocall Co.*, Shelby, Ohio.)

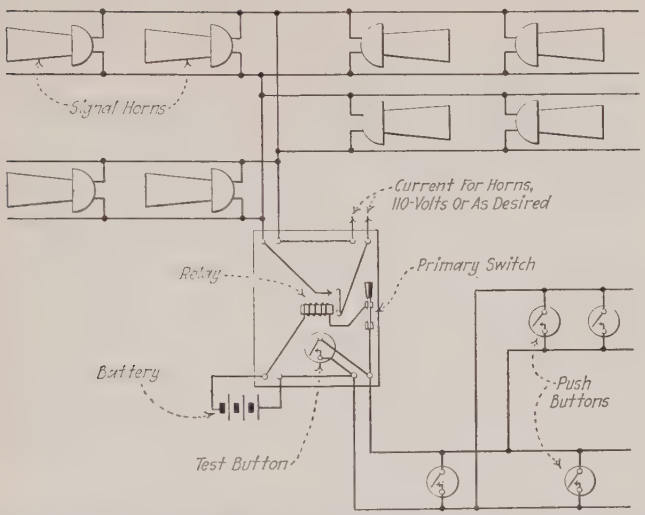


FIG. 174.—Schematic diagram of a factory-and-office signal system in which the signals are produced manually through various push buttons and a relay. (*Electrical Record*, June, 1920).

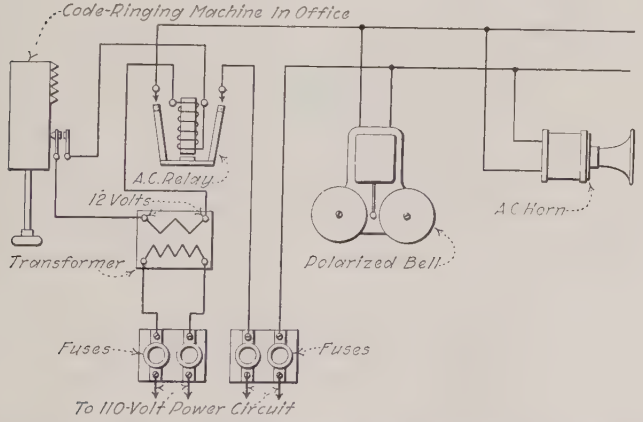


FIG. 175.—Wiring diagram of a Holtzer-Cabot alternating-current factory audible calling system using one relay. (HOLTZER-CABOT *Cat. No.* 4353.)

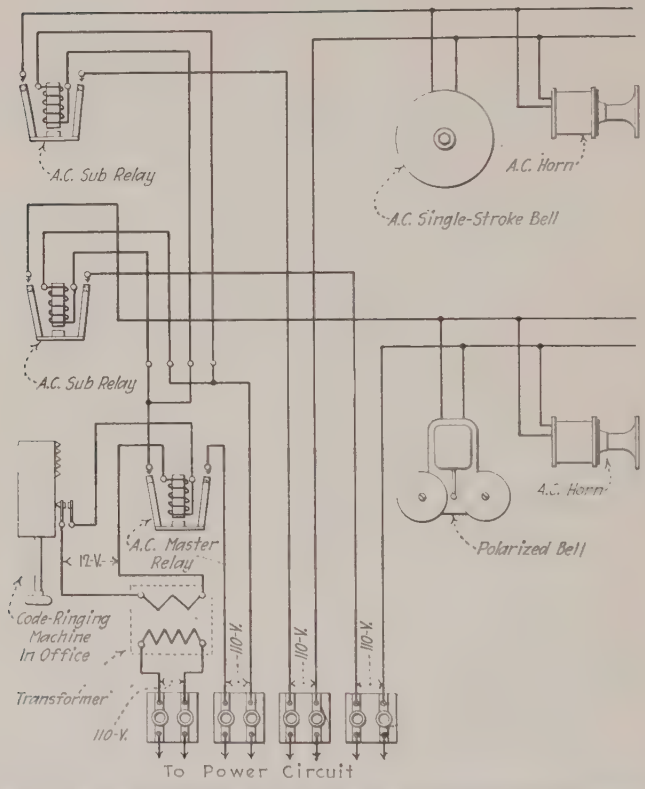


Fig. 176.—A wiring diagram of a two-circuit Holtzer-Cabot alternating-current factory audible calling system using one master relay and one or more sub-relays. (Holtzer-Cabot, *Cat. No.* 4353.)

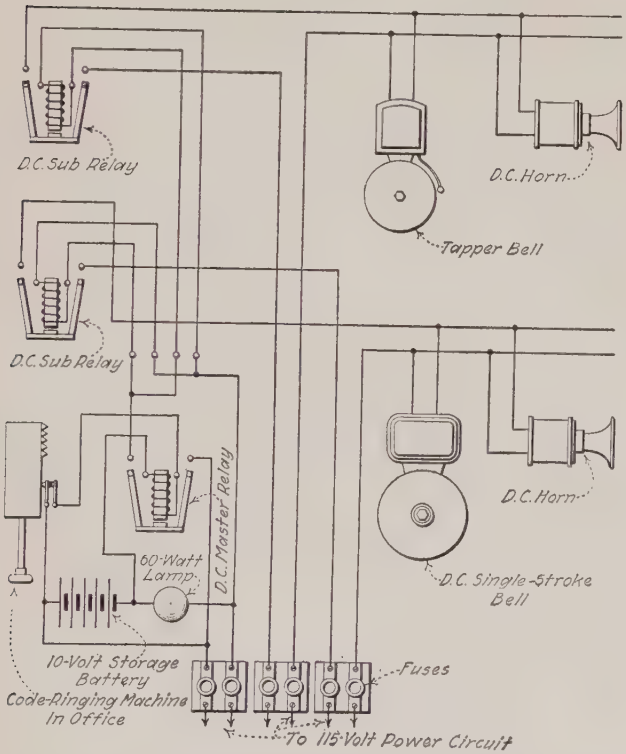


Fig. 177.—A wiring diagram of a two-circuit Holtzer-Cabot direct-current factory audible calling system, using one master relay and one or more sub-relays. (Holtzer-Cabot, *Cat. No.* 4353.)

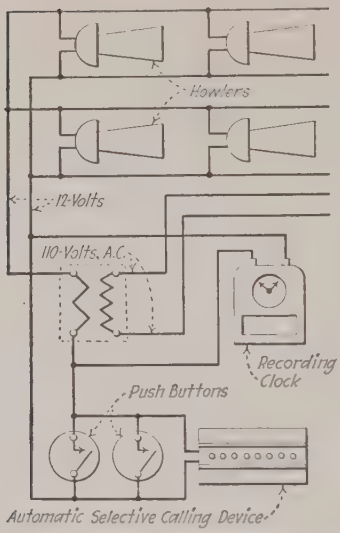


Fig. 178.—Diagram of an interior factory-calling system. This system employs a source of alternating-current using a transformer to reduce the voltage to the desired voltage. A master clock is connected into the circuit to sound the factory time schedule. (Benjamin Electric Co., *Bull.* 53.)

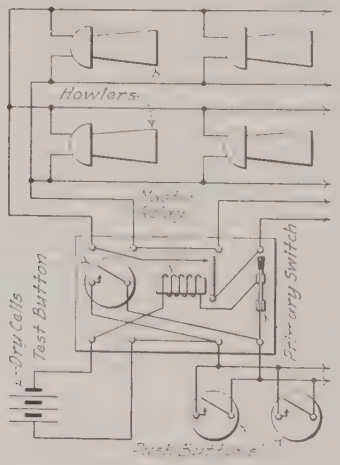


Fig. 179.—Wiring diagram of a manually-operated calling system which may be used also as an emergency fire alarm. By pressing one of the push buttons the low-voltage battery circuit, which is operated by three to six dry cells in series, is closed through the master relay coil, and the armature is drawn up. This in turn closes the relay circuit governing the supply of high-voltage current to the howlers. (Benjamin Industrial Signals, *Bull.* 53.)

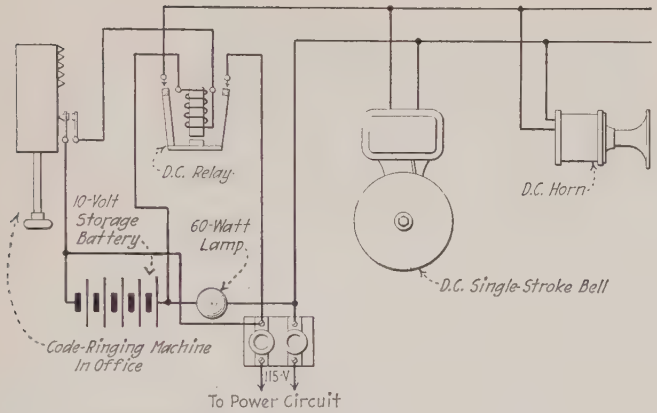


FIG. 180.—Wiring diagram of a Holtzer-Cabot direct-current factory audible calling system using one relay. (HOLTZER-CABOT, *Cat. No.* 4353.)

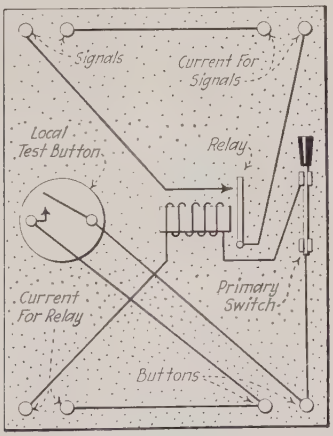


FIG. 181.—Wiring diagram of a relay panel used in conjunction with a signal system to obviate the carrying of a large current through a small contact in the transmitter. (Made by the BENJAMIN ELECTRIC MFG. CO., Chicago, Ill.)

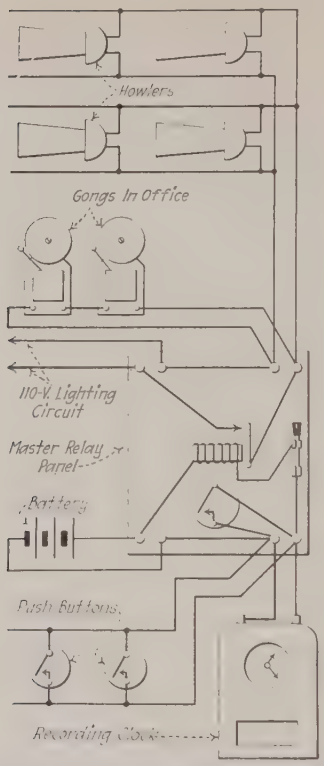


Fig. 182.—Connection diagram of a Benjamin master relay panel for controlling 110- to 250-volt current to industrial signals. (Benjamin Industrial Signals, *Bull.* 53.)

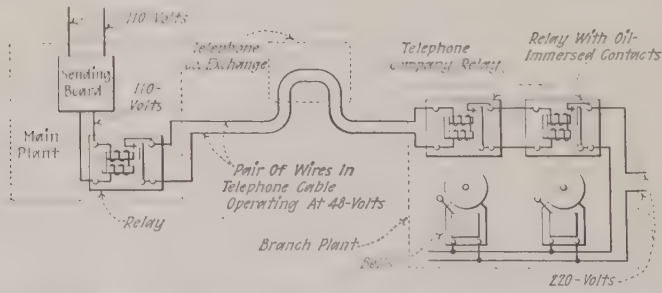


Fig. 183.—Schematic diagram illustrating the method of interconnecting the call system of two distant plants through the telephone company's lines. (*Electrical Review and Industrial Engineer*, March, 1922.)

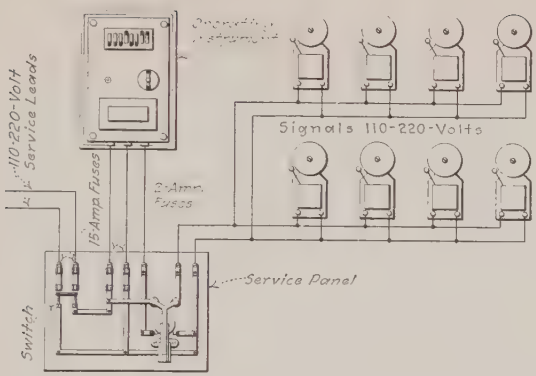


FIG. 184.—Wiring diagram for a National calling system, showing operating instrument service panel, and signals. (NATIONAL SCALE CO., Chicapee Falls, Mass.)

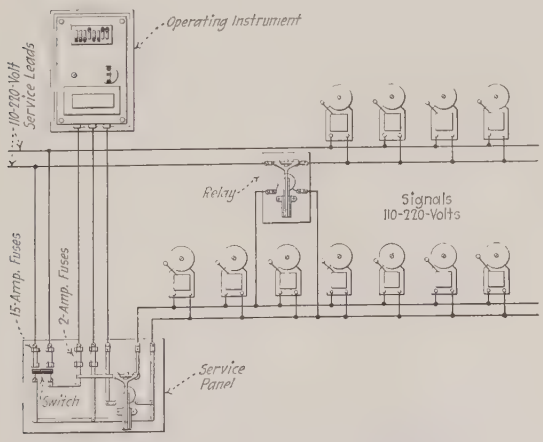


FIG. 185.—Wiring diagram for a National calling system with an extra relay. (NATIONAL SCALE CO., Chicapee Falls, Mass.)

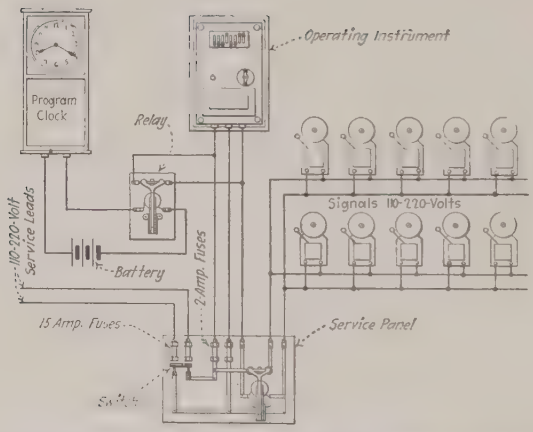


Fig. 186.—Wiring diagram for a National calling system wired in connection with a program clock. (National Scale Co., Chicapee Falls, Mass.)

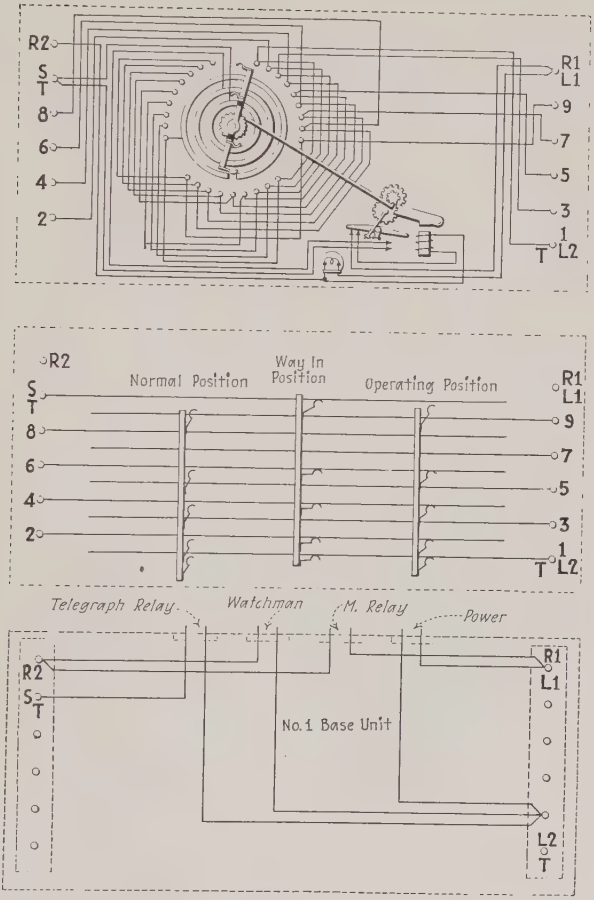
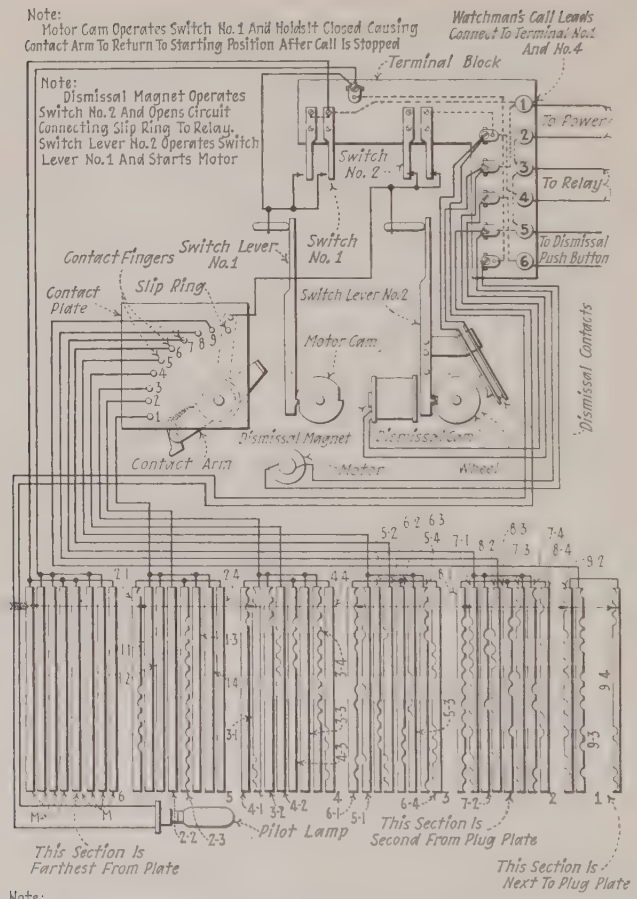


FIG. 187.—Wiring diagram for a signal-call sending station. (SIGNAL ENG. and MFG. CO.)


Note:
Motor Cam Operates Switch No. 1 And Holds It Closed Causing Contact Arm To Return To Starting Position After Call Is Stopped
Watchman's Call Leads Connect To Terminal No. 1 And No. 4
Terminal Block
Note:
Dismissal Magnet Operates Switch No. 2 And Opens Circuit Connecting Slip Ring To Relay. Switch Lever No. 2 Operates Switch Lever No. 1 And Starts Motor
To Power
To Relay
To Dismissal Push Button
Switch No. 2
Switch No. 1
Contact Fingers
Switch Lever No. 1
Contact Plate
Slip Ring
Switch Lever No. 2
Motor Cam
Dismissal Contacts
Dismissal Magnet
Dismissal Cam
Contact Arm
Motor
Wheel
Pilot Lamp
This Section Is Farthest From Plate
This Section Is Second From Plug Plate
This Section Is Next To Plug Plate

Note:
All Divisions In Each Section Contain Two Contact Bars, Numbered As Shown. Number On Left Indicates The Number Of Finger That Bar Connects To. The Number On Right Indicates The Division That Bar Occupies In All Sections. Thus, Bar No. 5-1 Connects To Finger No. 5 And Is In The Top Section. It Is In The Third Insulator From Plug Plate

FIG. 188.—Wiring diagram of an Autocall transmitter, Model 16-A 60-call with dismissal and watchman call buttons. The arrow indicates the position of the plug when the call is "2." The heavy parts of the arrow show that the arrow is in the top section of the board.

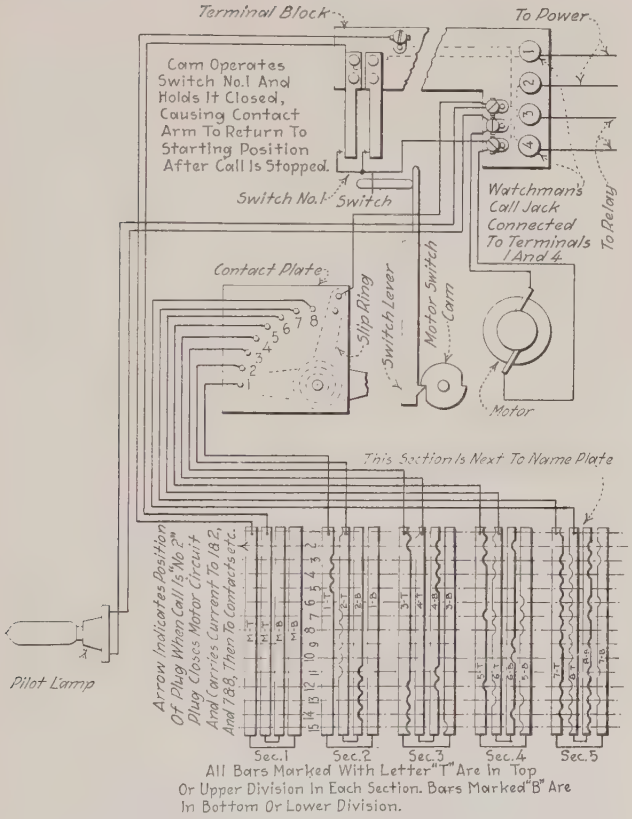

Terminal Block
To Power
Cam Operates Switch No.1 And Holds It Closed, Causing Contact Arm To Return To Starting Position After Call Is Stopped.
Switch No.1 Switch
Watchman's Call Jack Connected To Terminals 1 And 4.
To Relay
Contact Plate
Slip Ring
Switch Lever
Motor Switch Cam
Motor
This Section Is Next To Name Plate
Arrow Indicates Position Of Plug When Call Is "No. 2" Plug Closes Motor Circuit And Carries Current To 1 & 2, And 7 & 8, Then To Contacts etc.
Pilot Lamp
Sec. 1
Sec. 2
Sec. 3
Sec. 4
Sec. 5
All Bars Marked With Letter "T" Are In Top Or Upper Division In Each Section. Bars Marked "B" Are In Bottom Or Lower Division.

FIG. 189.—Wiring diagram of an Autocall transmitter Model 16-A. This shows a 30-call outfit.

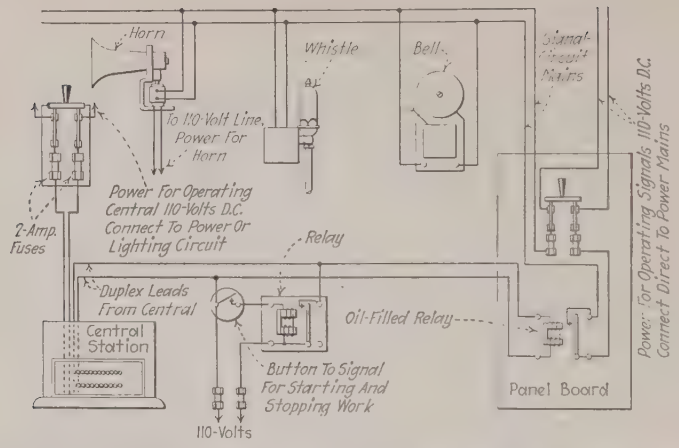


Fig. 190.—Connection diagram for a signalling system for calling department heads of an industrial plant. When the operator plugs into the sending station, signals sound in all parts of the plant. (*Electrical Review and Industrial Engineer*, March, 1922.)

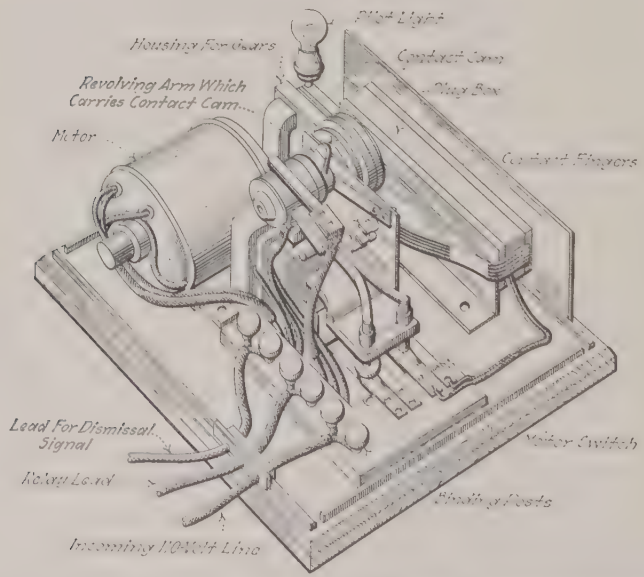


Fig. 191.– Illustration of the mechanism of a Model 16-A Autocall transmitter.

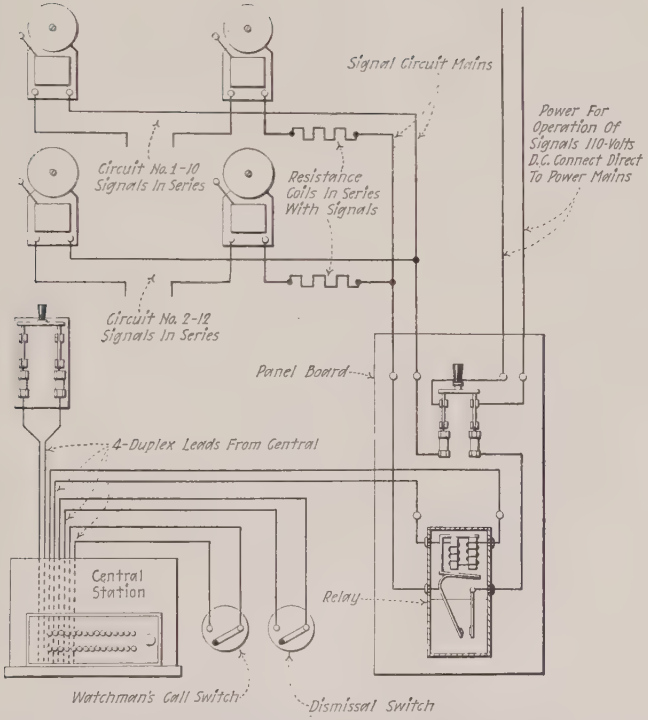

Signal Circuit Mains
Power For Operation Of Signals 110-Volts D.C. Connect Direct To Power Mains
Circuit No. 1-10 Signals In Series
Resistance Coils In Series With Signals
Circuit No. 2-12 Signals In Series
Panel Board
4-Duplex Leads From Central
Central Station
Relay
Watchman's Call Switch
Dismissal Switch

FIG. 192.—Diagram showing connection for an auto-call system using a 110-volt direct-current source of current supply. (The AUTO-CALL CO., Shelby, Ohio.)

DIVISION 6

TELEPHONE CIRCUITS

DIVISION 6

TELEPHONE CIRCUITS

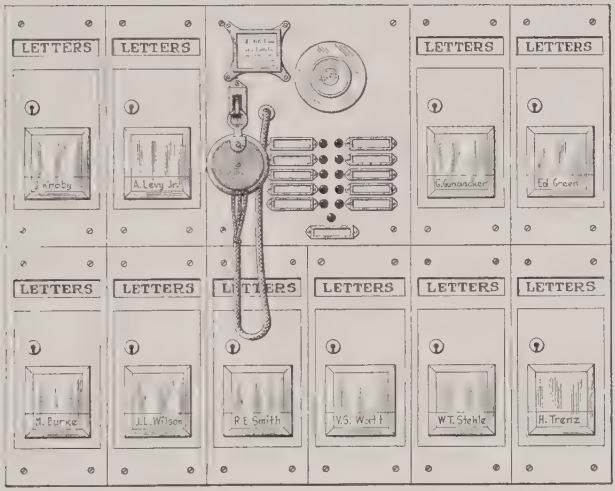


FIG. 193.—A typical apartment-house vestibule installation.

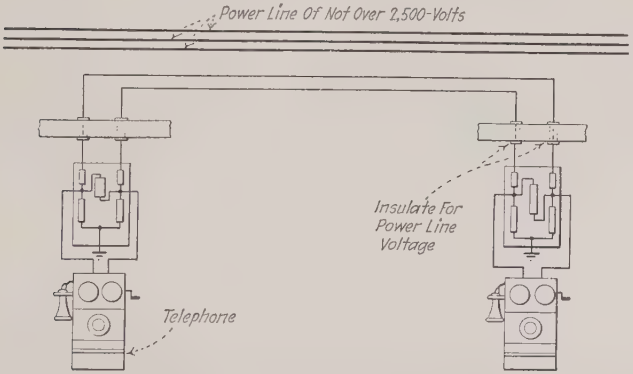


FIG. 194.—Diagram of telephone connections for circuits near 2500-volt transmission line.

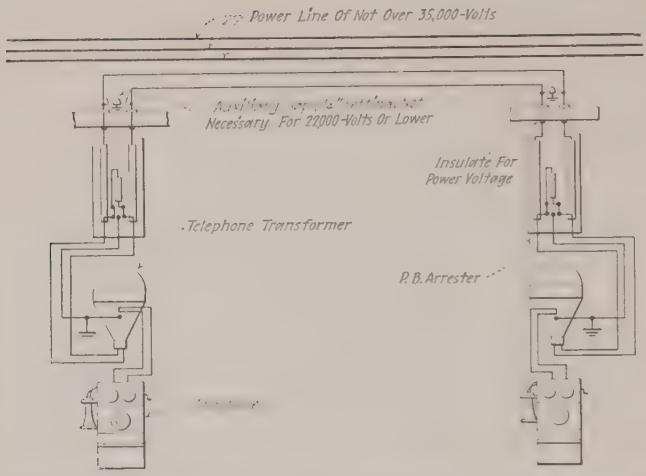


Fig. 195.—Telephone connections for circuits near power lines up to 35,000 volts.

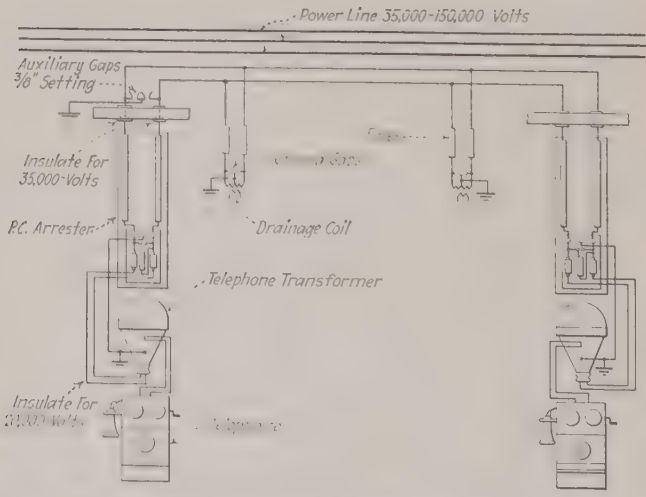


Fig. 196.—Telephone connections for circuits near very high voltage lines.

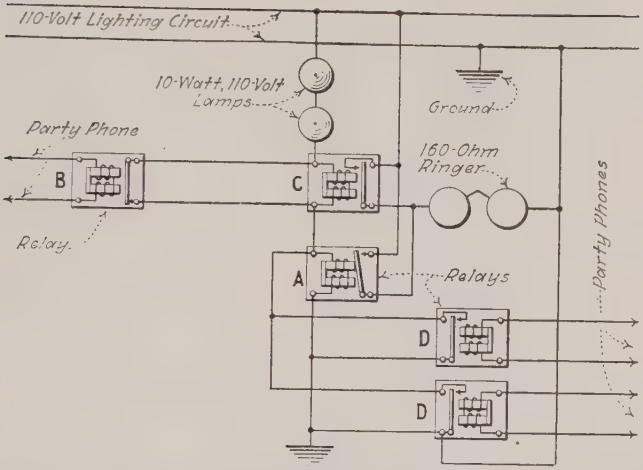


FIG. 197.—An arrangement whereby a large gong can be used on a power-station telephone circuit. This scheme was used successfully, for several years, by a large hydro-electro electric company. It comprises a number of "direct" telephone lines on which standard drops, *DD* are used, and a party line to which the special relay *B* is connected. Code signals are used on the party line. Two ordinary 20-ohm pony telegraph relays *A* and *C* have their magnet coils connected in series with two 10-watt lamps to the 110-volt grounded lighting circuit. When either of the drops *DD* fall, the magnet of relay *A* will be short-circuited, releasing the armature of *A* and closing the bell circuit. Several designs of relays were tried for the party line with unsatisfactory results, until the arrangement shown at *B* in connection with the relay *C* was used. Normally the magnet of relay *C* is short-circuited. When the drop *B* is energized the shunt around the magnet of relay *C* is opened, permitting current to flow through the relay *C*, closing the bell circuit; with this design it is claimed that "fast" code signals are clearly given and a signal from "central" attempted when a receiver is down comes in as clearly as a higher-voltage and lower-frequency signal from the nearest party. (*Electrical World*, May 6, 1916.)

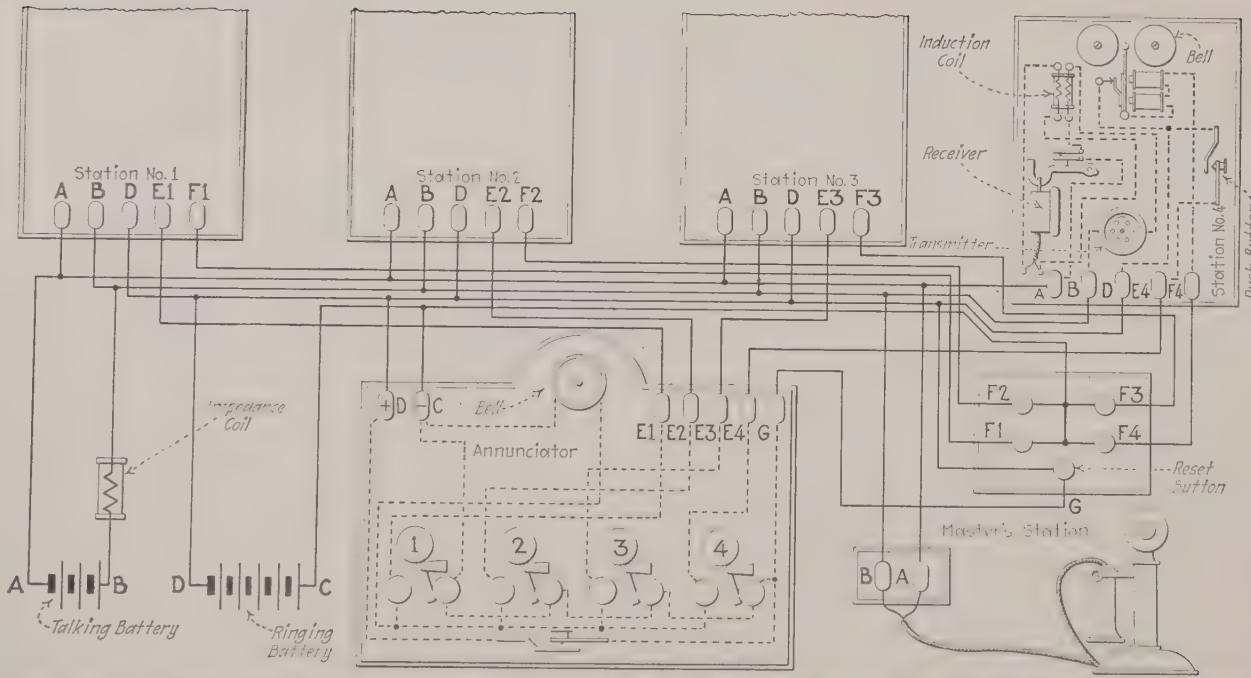


FIG. 198.—Wiring diagram of a four-station school telephone system. The principal can call any classroom telephone by pressing the corresponding button in the portable button block. Any of the class rooms can call the principal's office by pressing a button set in the telephone casing. This rings a bell in the principal's office and at the same time throws an indicator on the annunciator which also is located in the principal's office. He, therefore, can check all conversation and may, if he wishes to, eliminate unnecessary calls between classrooms. (HOLTZER-CABOT, Cat. No. 4353, *Bull.* 14,800.)

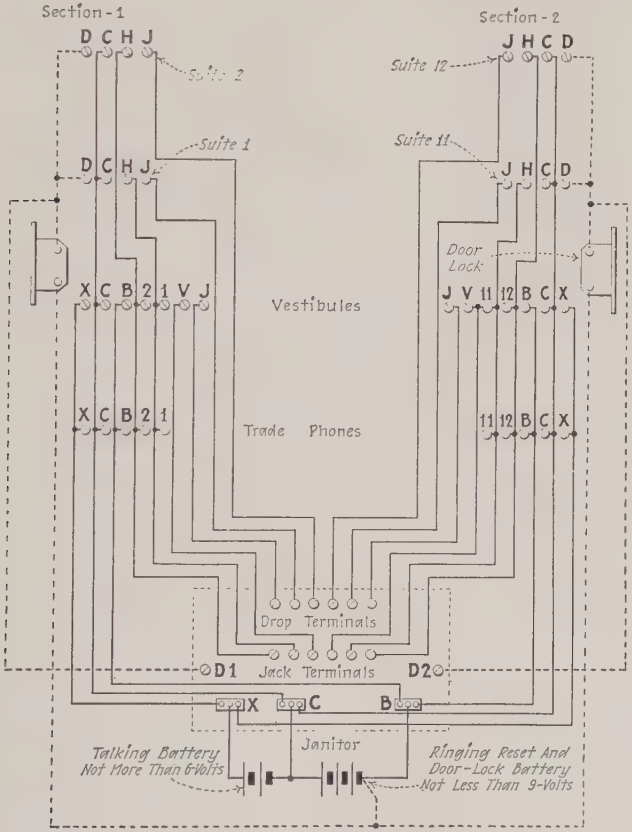


FIG. 199.—Wiring plan for a *S. H. Couch Company, Inc.*, non-interfering apartment-house telephone system.

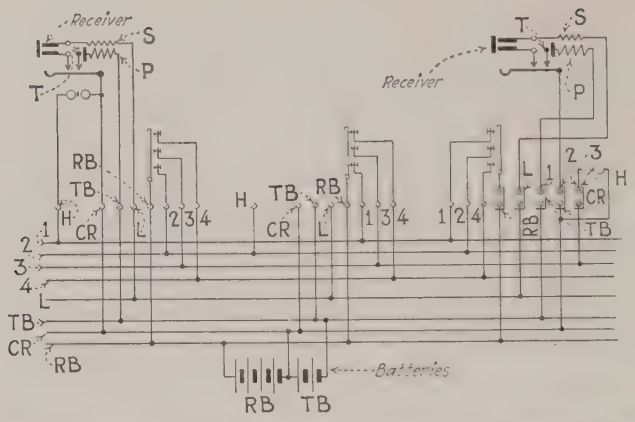


Fig. 200.—Wiring plan for a *Connecticut Telephone and Telegraph Company* common-talking selective-ringing intercommunicating telephone system.

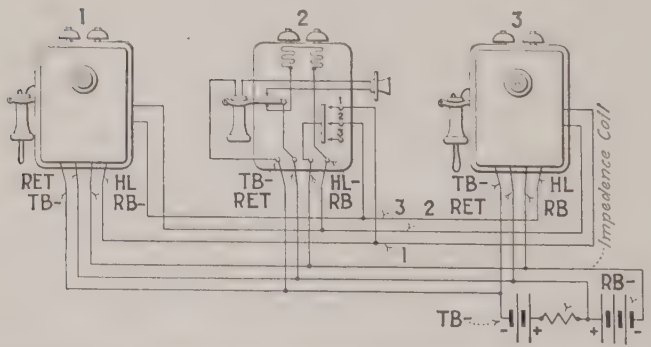


Fig. 201.—Wiring diagram for a *Stanley and Patterson* selective-ringing common-talking intercommunicating telephone system.

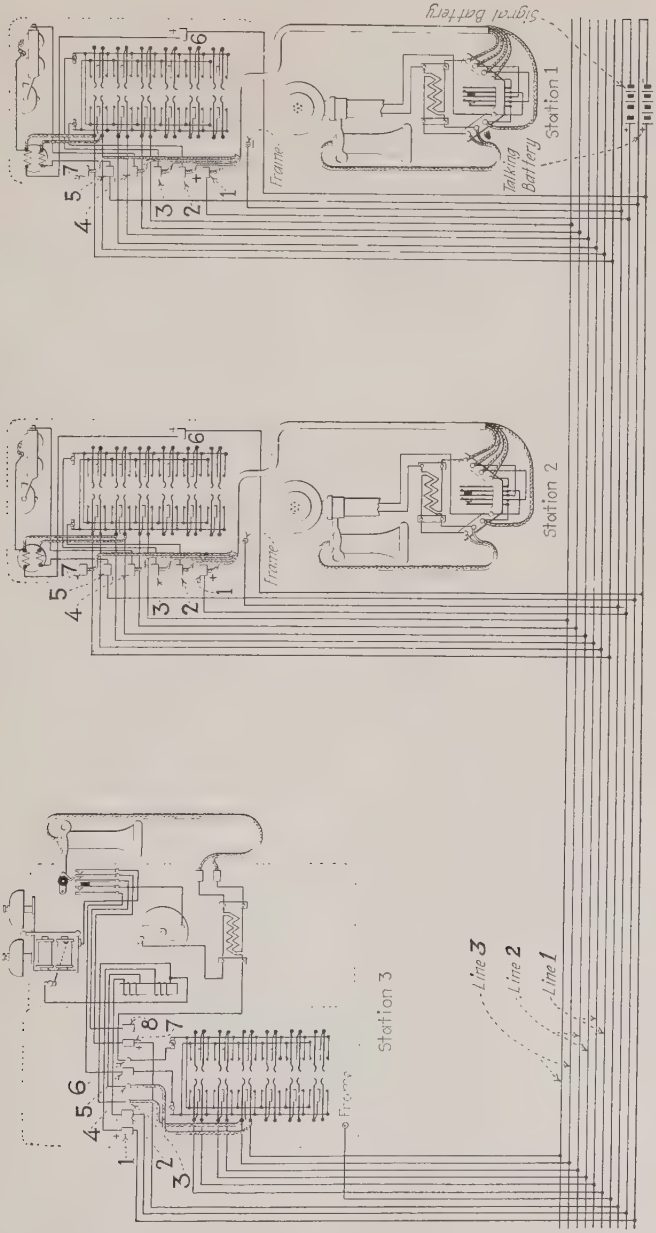


FIG. 202.—Wiring diagram for a Holtzer-Cabot selective-ringing, selective-talking intercommunicating telephone system.

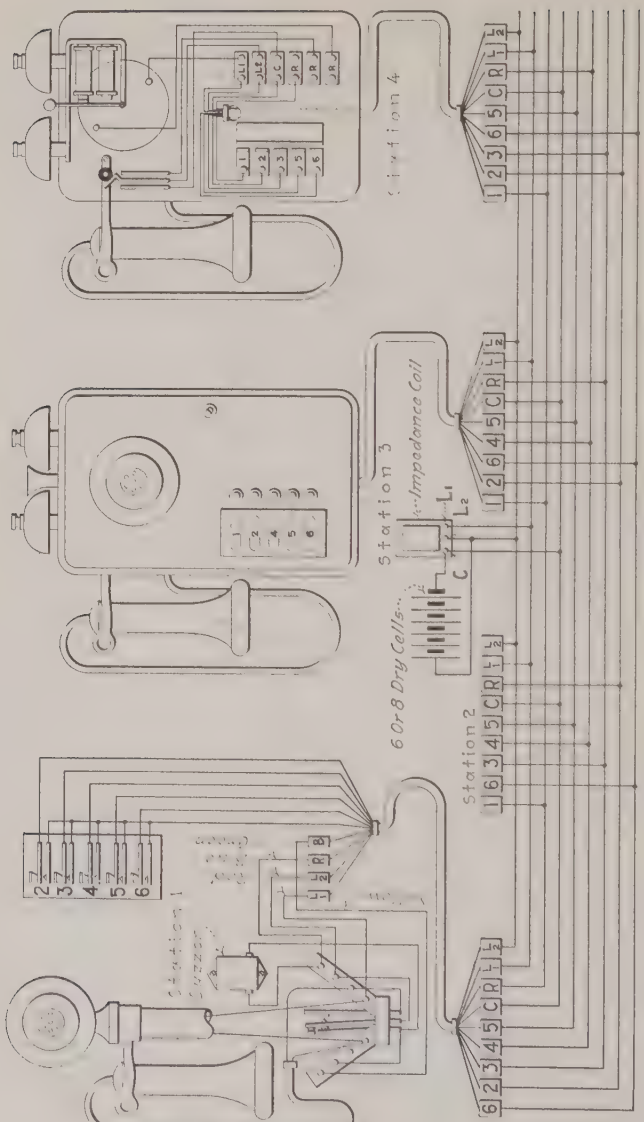


Fig. 203.—Wiring diagram for a Holtzer-Cabot selective-ringing, common-talking intercommunicating telephone system.

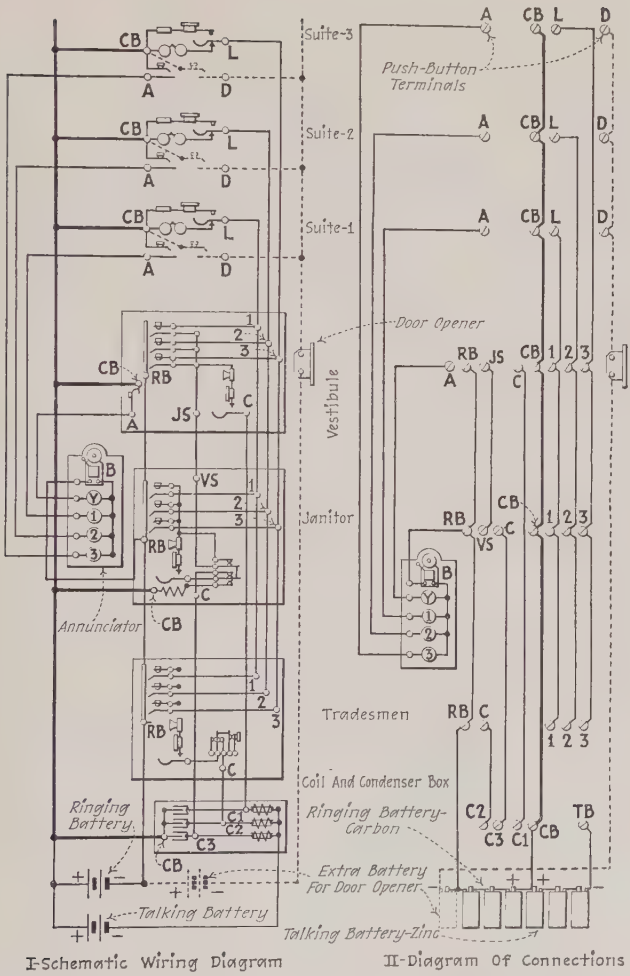


Fig. 204.—Wiring plan for a Western Electric Company apartment-house telephone system.

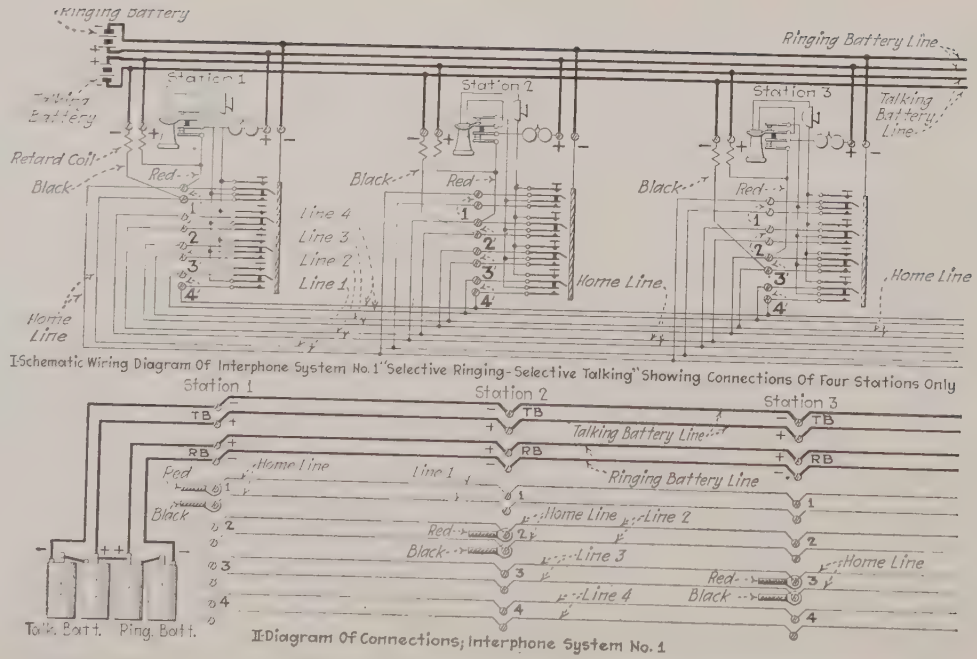


FIG. 205.—Wiring plan for a Western Electric Company full-metallic, selective-ringing, selective-talking interphone system.

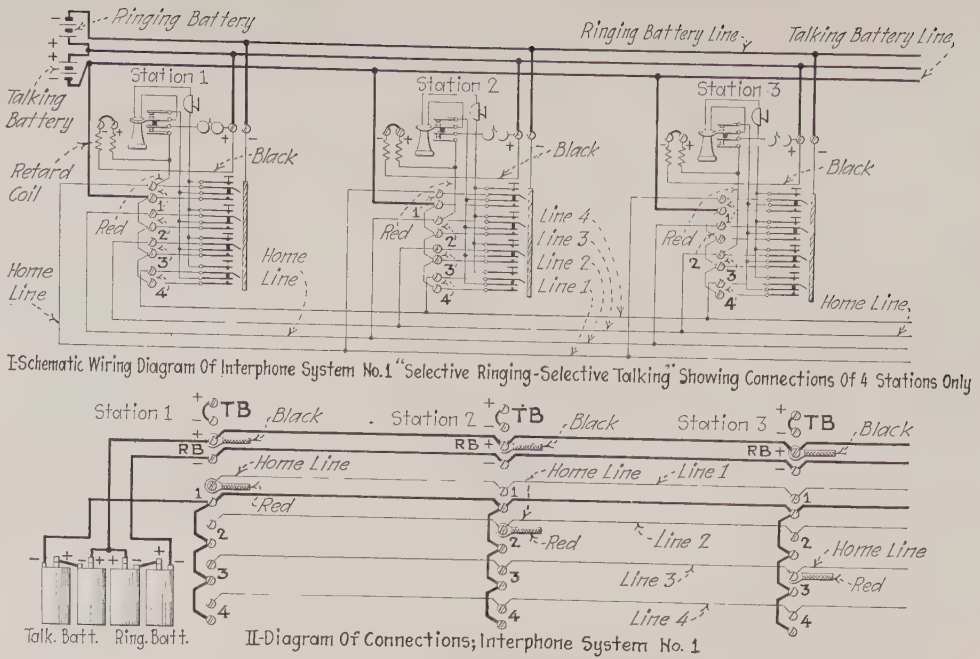


FIG. 206.—Wiring plan for a Western Electric Company common-return selective-ringing and selective-talking interphone system.

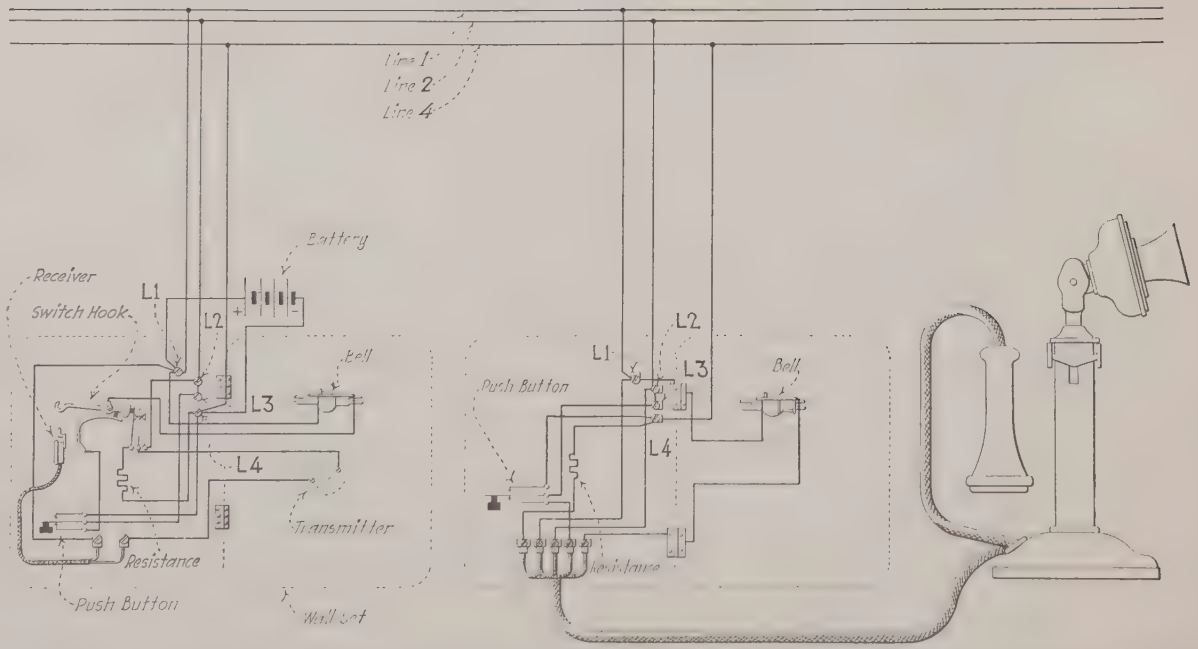


FIG. 207.—Connections for a *Western Electric Co.*, No. 6 private line system comprising two stations. In this system, from two to six telephones may be connected together and the different stations signalled by a system of code ringing. The bells are operated by battery current, a push button being mounted in each set by means of which any station may signal the others. The same battery is used for both talking and signalling. Three wires are required, which are common to both stations. (WESTERN ELECTRIC CO., *Bull.* 1105.)

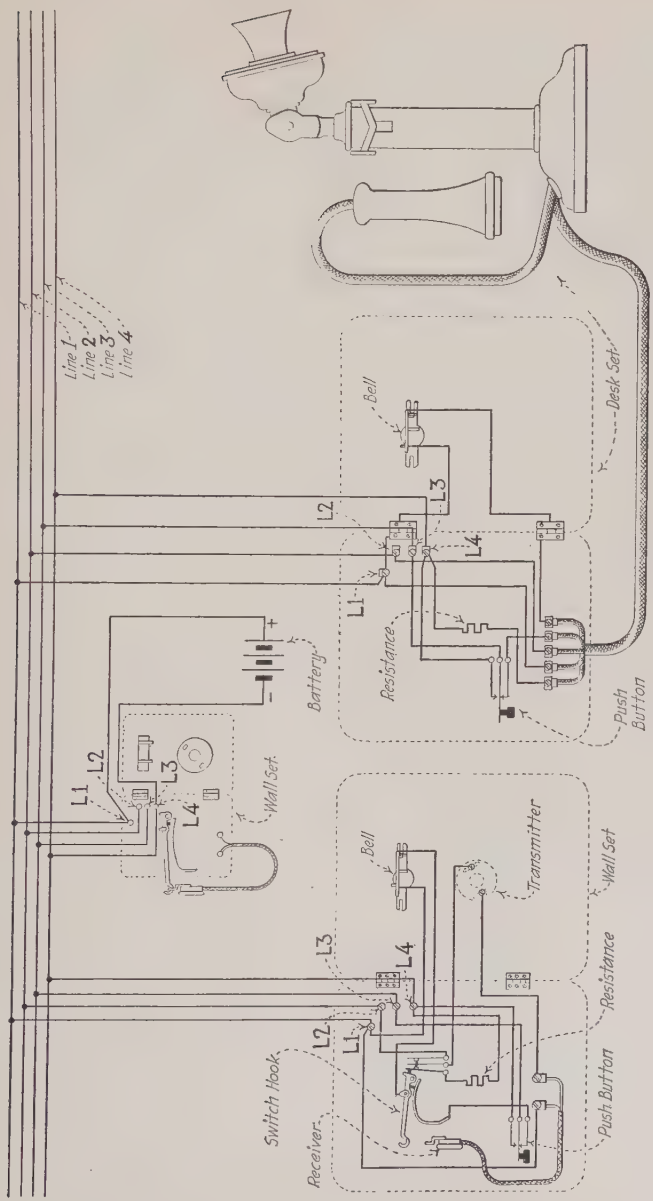


FIG. 208.—Connections for a Western Electric Co., No. 6 private-line system comprising three or more stations. In this system four wires are required and from three to eight dry cells.

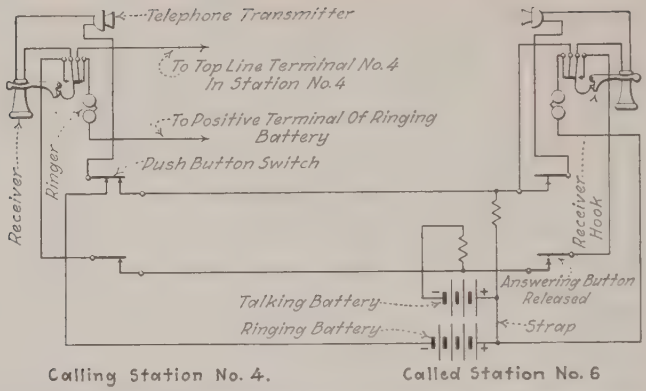


Fig. 209.—Circuits involved when a party at one station rings up a party at another station. (Western Electric Co., *Bull.* 1105.)

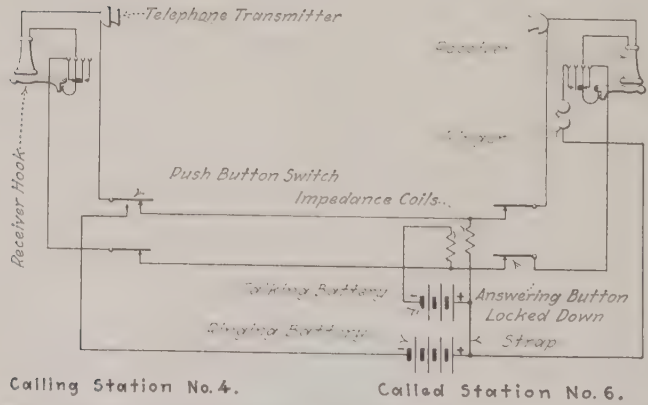


Fig. 210.—Circuits involved when two parties are conversing over an interphone system. (Western Electric Co., *Bull.* 1105.)

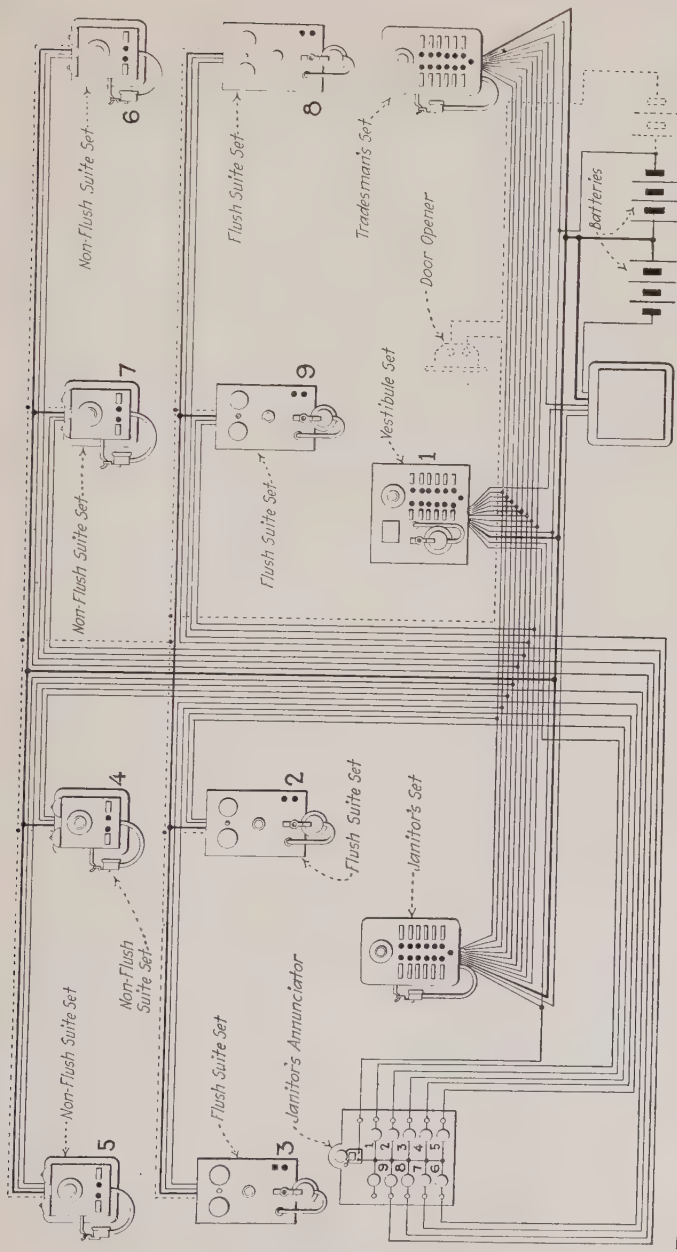


FIG. 211.—Wiring diagram of a complete Western Electric Co., No. 9 apartment-house interphone system showing connections for vestibule set, janitor's set, tradesman's set and suite sets.

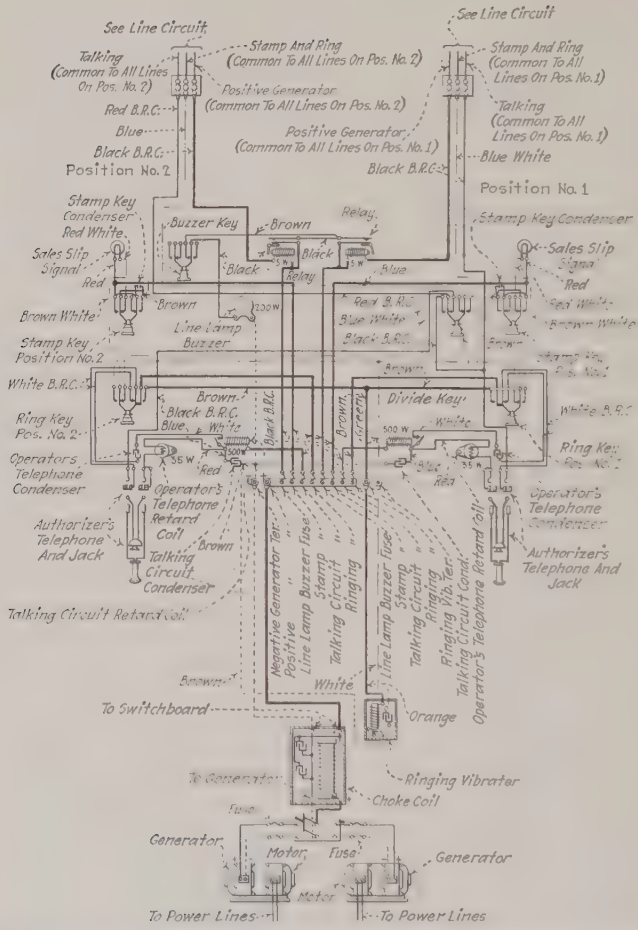


FIG. 212.—Wiring diagram of the authorizer's ringing, stamping and talking circuit of a National Cash Register Company's type "A" electrical credit system.

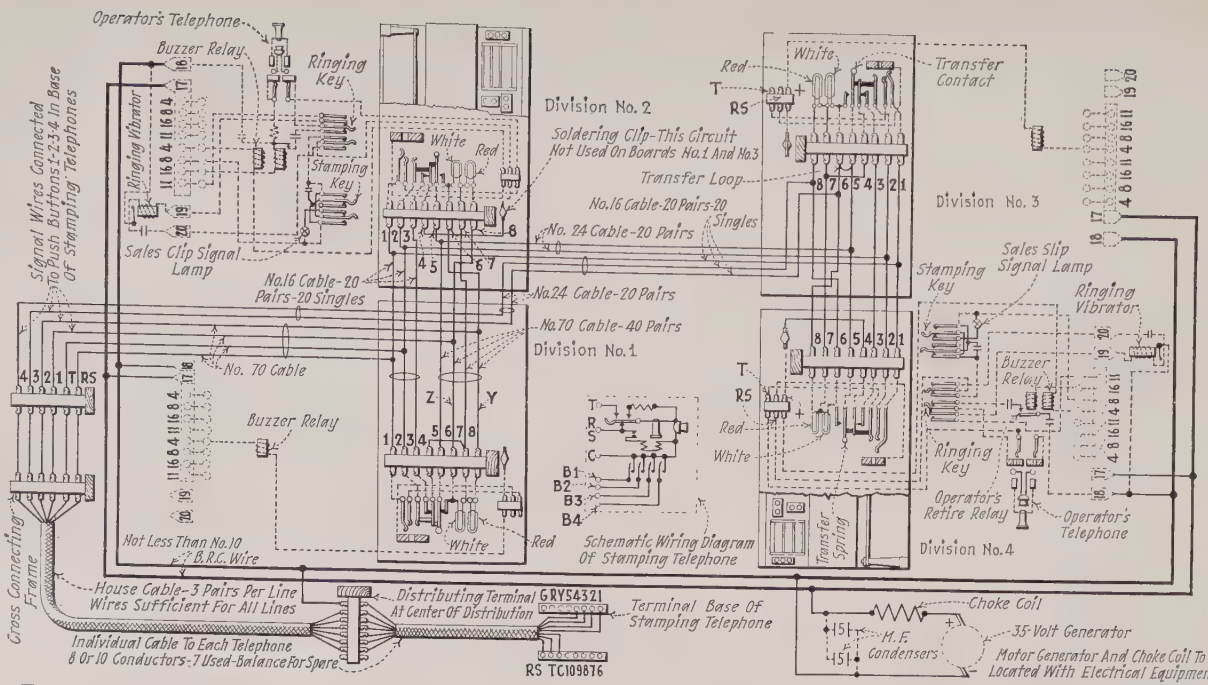


FIG. 213.—Wiring diagram of the National Cash Register Electrical Credit Telephone System (which is shown in Fig. 212) showing the complete circuit, in which all apparatus is connected in its proper location. The dotted lines indicate wires already in switchboards; circuits thus shown are not necessarily complete and are included in the diagram only to make clear the other connections.

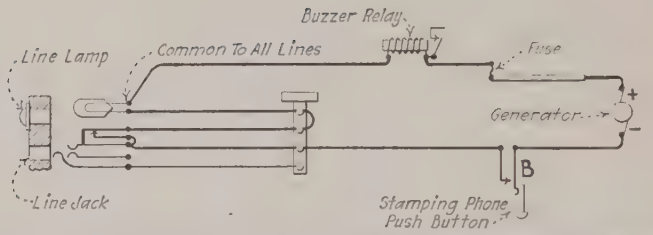


Fig. 214.—Simplified drawing of a credit-telephone system one-desk direct-call signal circuit. When the push button is pressed on the stamping telephone, it closes the circuit through contact *B*. This lights the lamp which signals the authorizer. (*The N. C. R. Electrical Credit System Instruction Book.*)

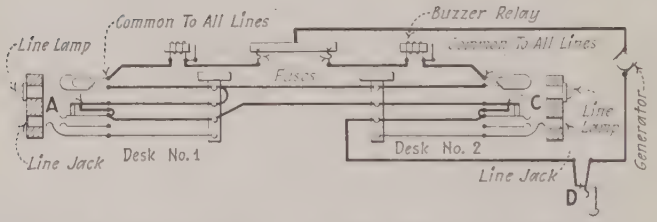


Fig. 215.—Simplified diagram of a two-desk direct-call credit-telephone signal circuit. When the push button at the stamping telephone is pressed, it closes the circuit through contact *D* to the negative (−) side of the battery. A line lamp, on each of the two desks, is illuminated. This gives two authorizers access to the call. When the plug is inserted in either board, it opens contact *A* or *C*, putting out both lights. (*The N. C. R. Electrical Credit System Instruction Book.*)

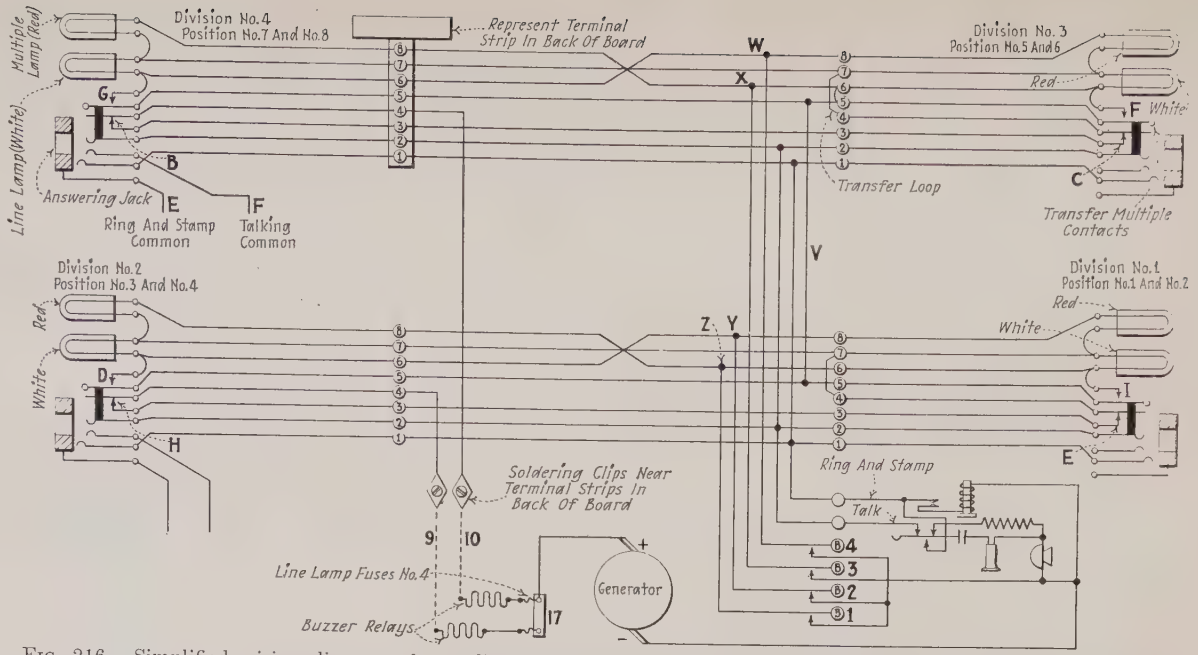


FIG. 216.—Simplified wiring diagram of a credit-telephone system four-division selective-line signal circuit. This shows a four-division signal circuit arranged with a combination jack for switching all lines to "Division 3." The selective system is so arranged that the clerk who is using the stamping telephone may call any certain division of the switchboard by pressing the corresponding button. The selective system permits arranging the alphabet in two or more divisions and selecting the proper division by pressing the corresponding button on the stamping telephone in the department which makes the sale. (*The N. C. R. Electrical Credit System Instruction Book.*)

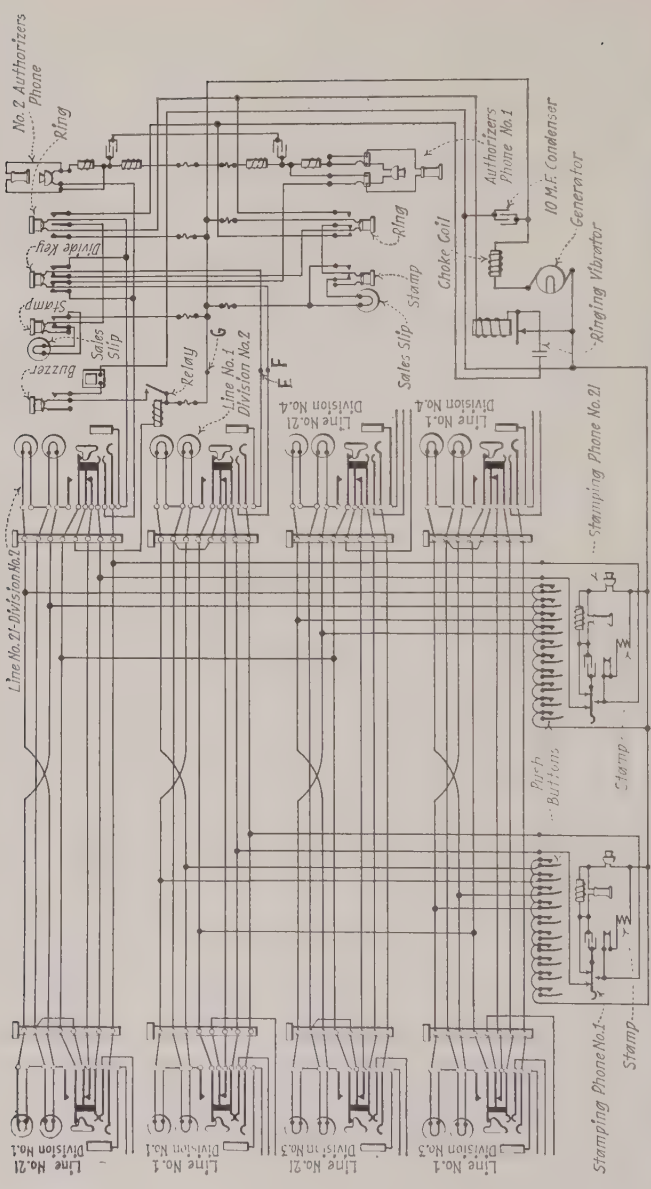


FIG. 217.—Wiring diagram of a four-division selective circuit showing the complete circuit with two telephones connected. Division 3 is connected for transfer section. (*The N. C. R. Electrical Credit System Instruction Book.*)

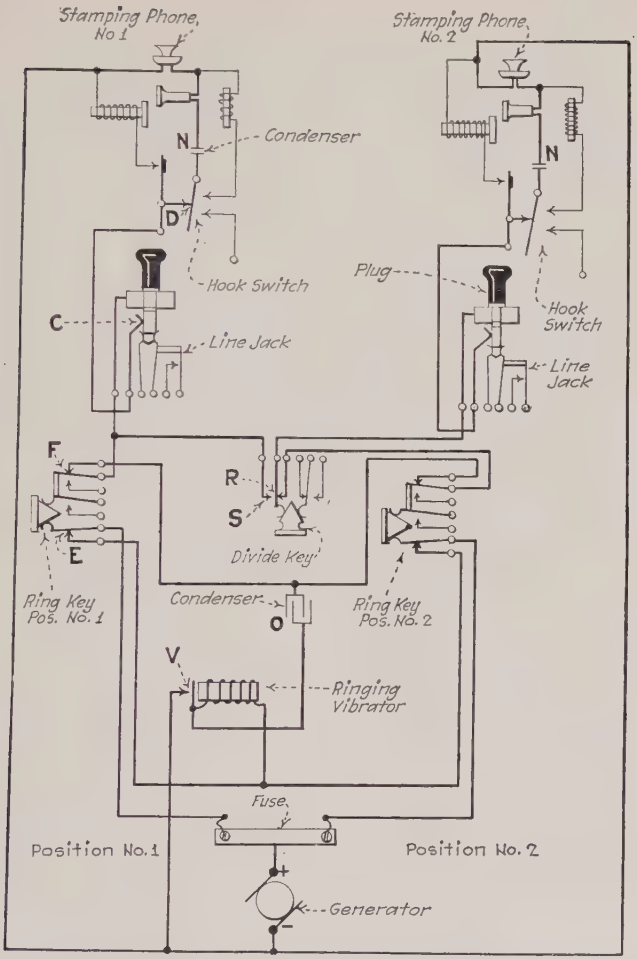


FIG. 218.—Wiring diagram of the credit-telephone-system ringing circuit. When the ringing key in "Position 1" is pressed, a circuit is completed through vibrator coil. The making and breaking of contact *V* of the vibrator coil causes a pulsating current to flow through the condenser *O*, contact *F*, line jack, hook switch, *D*, condenser *N*, through the receiver, returning to the generator through the transmitter. This causes an audible clicking sound to be set up in the receiver which attracts the attention of the clerk. (*The N. C. R. Electrical Credit System Instruction Book.*)

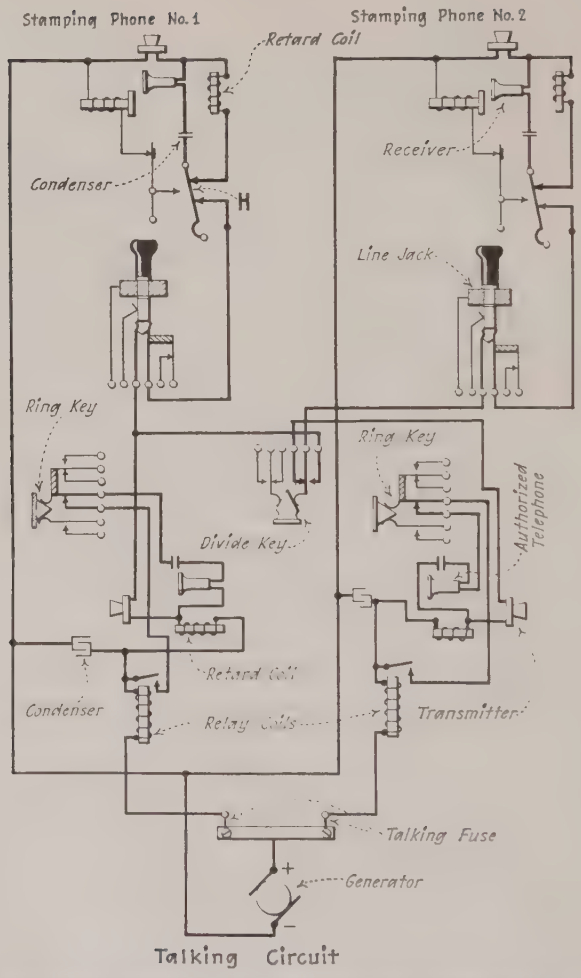


Fig. 219.— Wiring diagram of the National Cash Register Company credit-telephone talking circuit. This illustrates conditions when the receiver is removed from the hook, closing contact, "H," and the plug is in the line jack, the circuit being established between the stamping telephone and the authorizer's telephone. (*The N. C. R. Electrical Credit System Instruction Book.*)

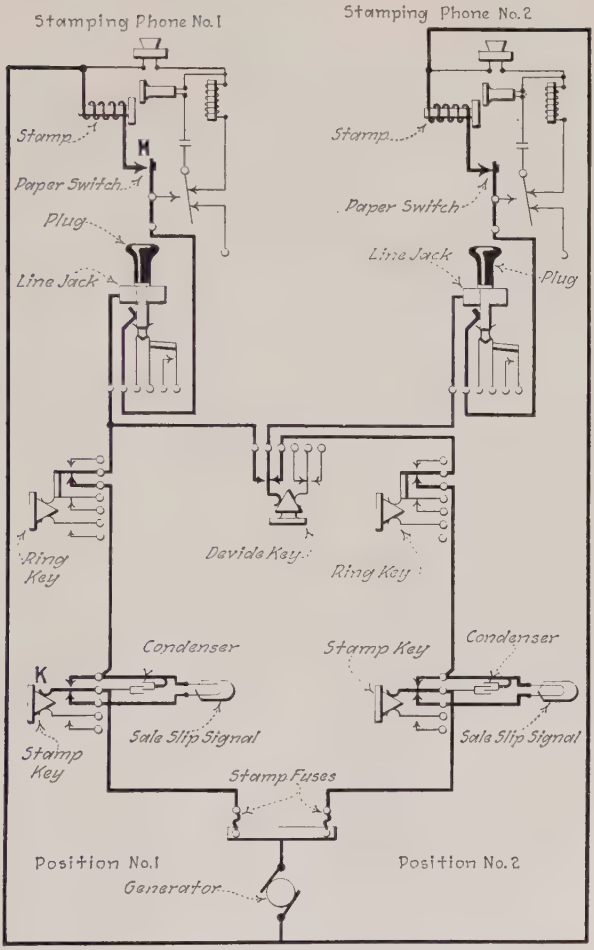


FIG. 220.—Wiring diagram of the credit-telephone stamping circuit. When the sales slip is inserted in the stamping telephone, which closes the paper switch *M*, and the operator's plug is in the line jack, a circuit is (when the "stamp key" is pressed) completed through contact *K* of stamping key, through and out to the negative terminal of generator. The stamp cannot be operated unless paper switch *M* in the stamping phone is closed. (*The N. C. R. Electrical Credit System Instruction Book.*)

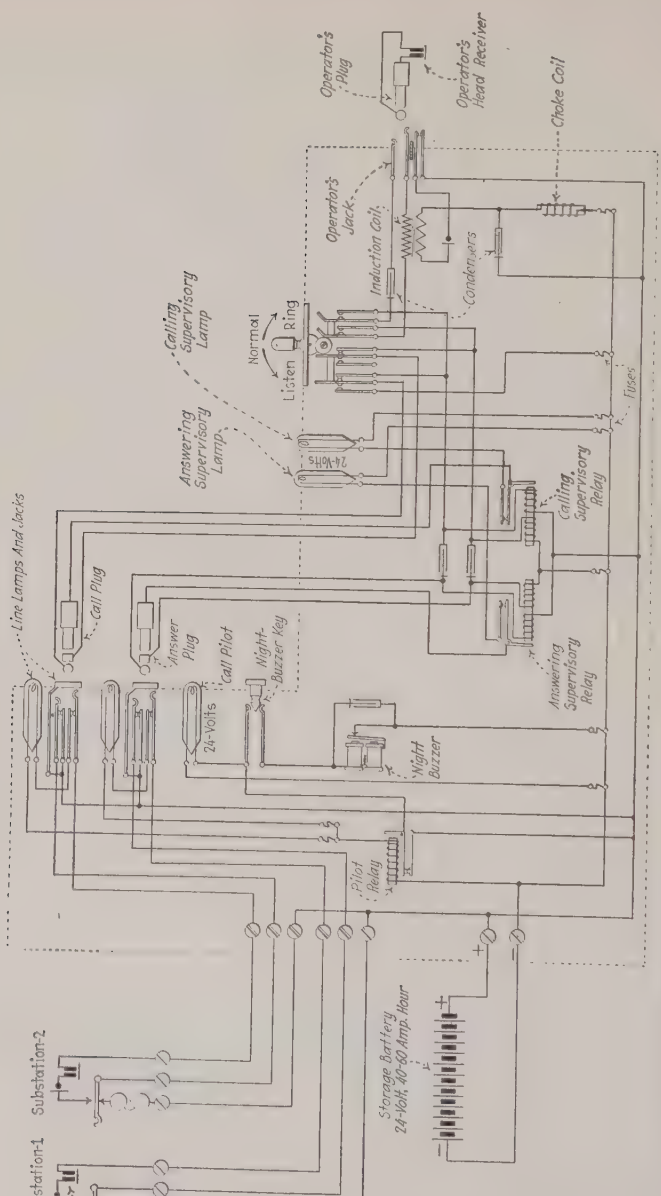


Fig. 221.—Wiring diagram of an S. H. Couch Co., common-battery manual telephone switchboard system 51.

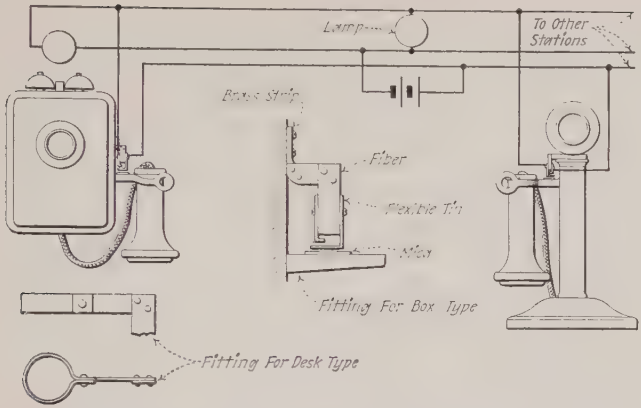


FIG. 222.—A visual telephone signal which indicates when the line is in use. The scheme is used where several telephones are connected to the same line. This contactor would probably not be accepted by an insurance inspector; it does not conform to the requirements of the Underwriter's Laboratories.

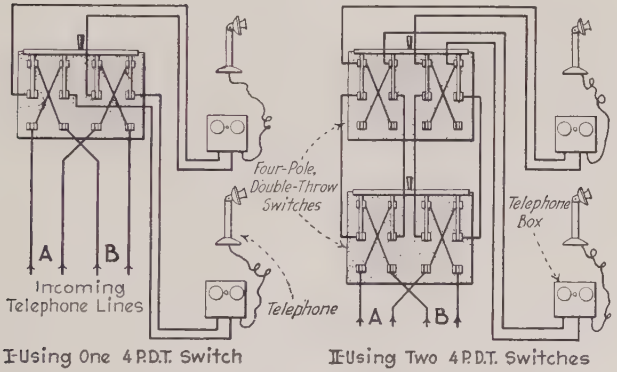
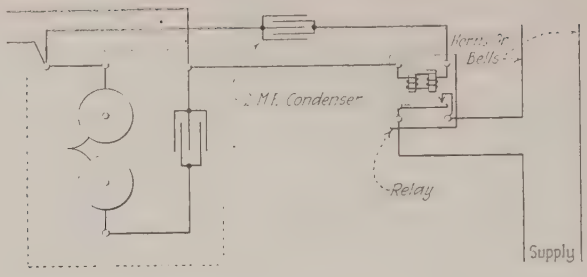
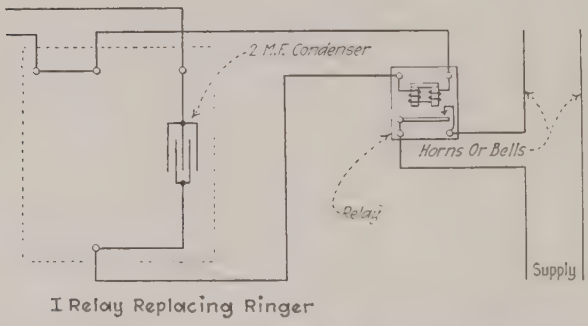


FIG. 223.—Wiring diagrams showing methods of connecting telephone change-over switches. This scheme was used in an office which had two telephone services, with a telephone on each partner's desk. Both phones were under the firm name and considerable trouble was caused by the wrong partner being called. The trouble was temporarily solved by utilizing a 4-pole double-throw switch as shown in *I*, which was of the heel-and-toe or transfer type. With this arrangement if the wrong partner answered the phone, it was simply necessary to place the switch in the opposite direction to transfer the call to the opposite phone. Figure *II* shows a system using two 4-pole double-throw switches, which enables either phones to be put on either line from either desk.



1-Relay And 2 M.F. Condenser Across Line



1 Relay Replacing Ringer

Fig. 224.—Wiring diagram for type At-1 signal telephone extension relay manufactured by the *Signal Engineering and Mfg. Co.*, New York City.

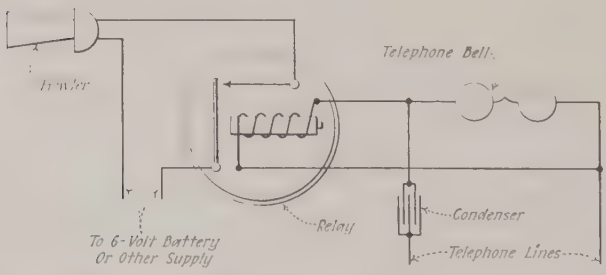


Fig. 225.—Method of connecting a signal horn to a telephone line, for operation on a local battery through a relay.

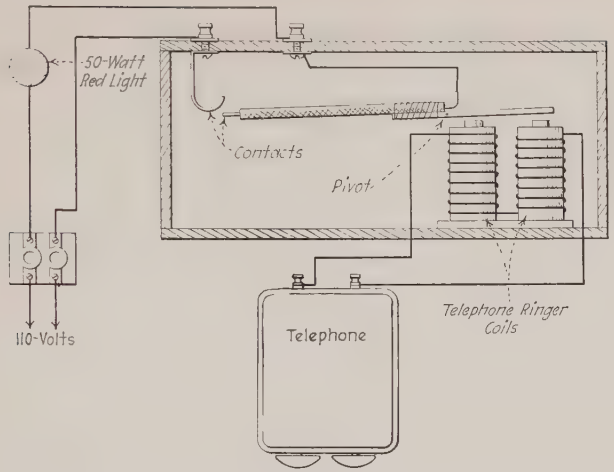


FIG. 226.—A home-made relay for an extension signal on a telephone circuit. When the telephone rings, the relay, which is connected to the ringer circuit of the telephone circuit, closes a signal-lamp circuit which notifies the observer of a telephone call. This scheme is particularly suitable for noisy plants where an audible signal may not always attract attention. (*Power Plant Engineering*, Sept., 1919.)

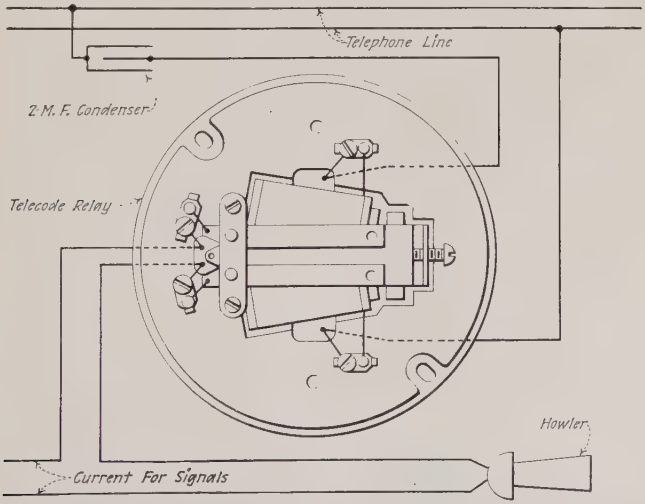


FIG. 227.—Diagram showing the connections for a *Telecode Relay* used in connection with an industrial howler on a telephone extension signal. (BENJAMIN INDUSTRIAL SIGNALS, *Bull.* 53.)

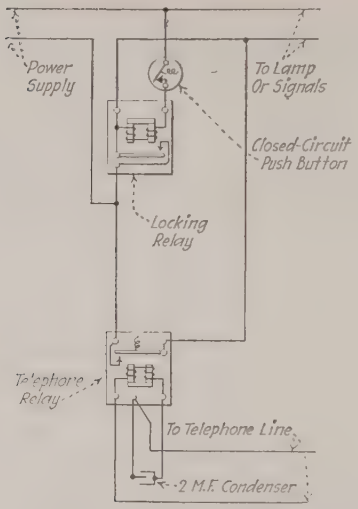


Fig. 228.—Wiring diagram for a signal telephone-extension relay.

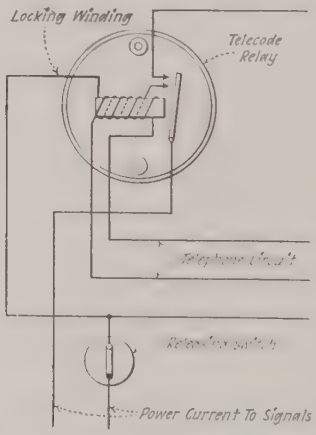


Fig. 229.—Diagram of an extension telephone signal circuit using a locking relay. When contact is formed by the telephone current actuating the relay magnet, the power circuit locks the armature in contact until the circuit is broken by means of the releasing switch. This gives a continuous warning, stopped only on releasing the relay by an exterior circuit breaking switch. (Benjamin Industrial Signals, *Bull.* 53.)

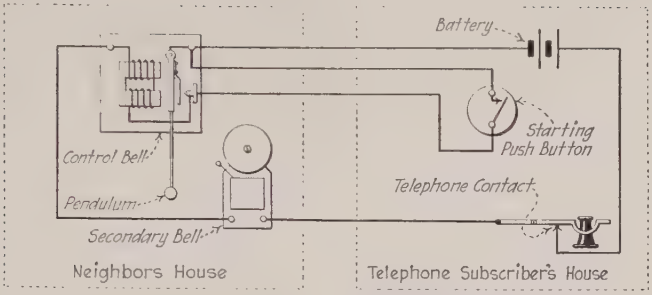


Fig. 230.—An automatic call bell. This circuit was devised to call a neighbor to a telephone subscriber's house in response to a telephone call. The circuit was so arranged that once the call bell started ringing, it continued to ring until the telephone call was answered. The control bell is of the ordinary vibrating type with a long pendulum, the contacts of which are arranged to be out of contact, until the pendulum is put in motion by pressing the starting button. The secondary bell, in the neighbor's house is connected as a single stroke gong so that it merely repeats each slow stroke of the control bell. This distinguishes a telephone call from other uses to which the bell may be put. The secondary bell circuit is broken when the receiver hook on the telephone is raised. This also interrupts the control bell circuit which stops the motion of the pendulum.

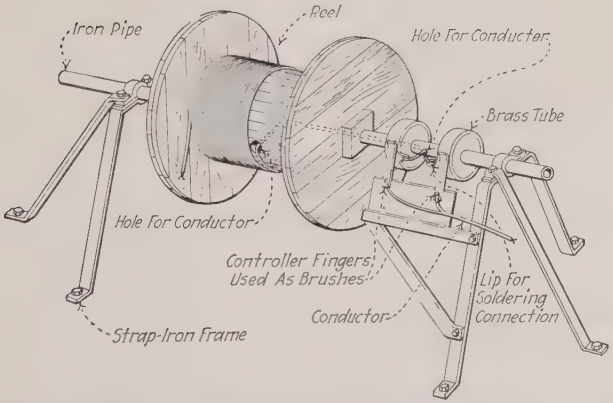


Fig. 231.—A telephone cable reel which was designed for use on a dredger to prevent interruption of telephone service with the shore. (*Industrial Engineer*, Nov., 1924.)

DIVISION 7

FIRE-ALARM CIRCUITS

DIVISION 7

FIRE-ALARM CIRCUITS

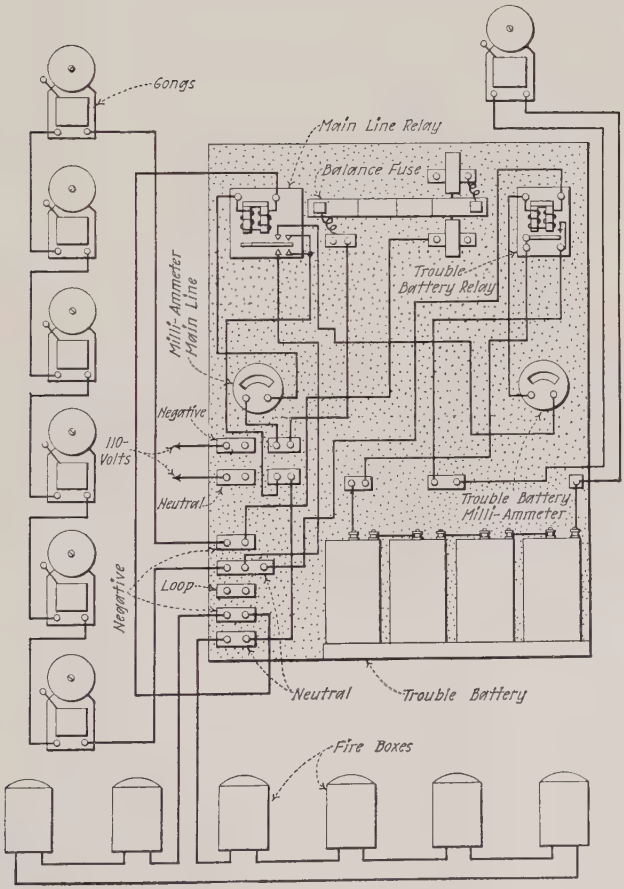


FIG. 232.—Wiring diagram for a type "SS" fire-alarm system, manufactured by the *W. R. Ostrander and Co.*, 371 Broadway, New York City.

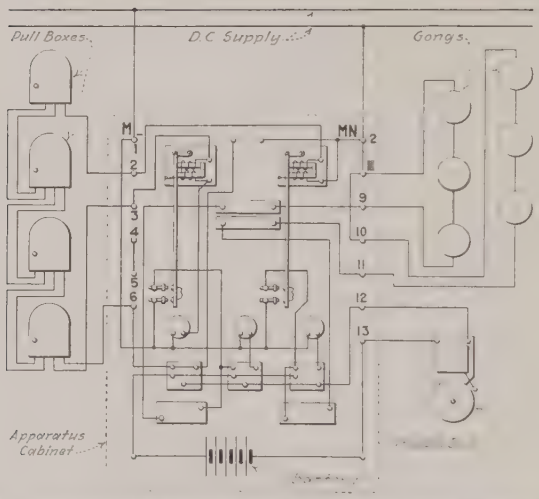


Fig. 233.—Wiring diagram of a pre-signal electrically-supervised closed-circuit code-ringing fire-alarm system, suitable for hotels or apartment houses. It derives current from a storage battery, but may be equipped to use 110-volt direct-current from a lighting circuit. There is a constant flow of current through the bells and pull boxes, but not enough to operate the system. When a box is pulled, the resistance in the circuit is cut out and the gongs are connected directly across the 110-volt mains during the instant the box circuit is open. By a separate make-and-break system for each box, a code is established, the mechanism alternately opening and closing the circuit. When one box is pulled the operation of another box will not interfere, but will sound in succession, a jumbled signal being impossible. (*Journal of Electricity and Western Industry*, Jan. 1, 1922.)

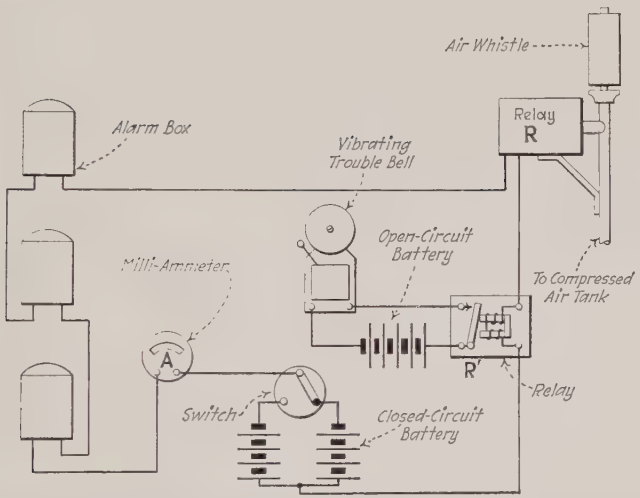


Fig. 234.—Diagram illustrating a fire-alarm system especially adapted to factories. The alarm sounds an air whistle which gives the warning. The primary battery is in duplicate so that when one battery is in service the other is being charged. The milliameter will indicate the condition of the battery. The open-circuit battery will operate the vibrating trouble-bell when the local circuit is closed through the relay *R*. This relay will operate when the main circuit is opened, either accidentally or when a box is pulled. If there happens to be a break in the line, the vibrating bell will ring continuously unless shut off or the trouble is remedied. (*Electrical Review and Western Electrician*, Aug. 15, 1914.)

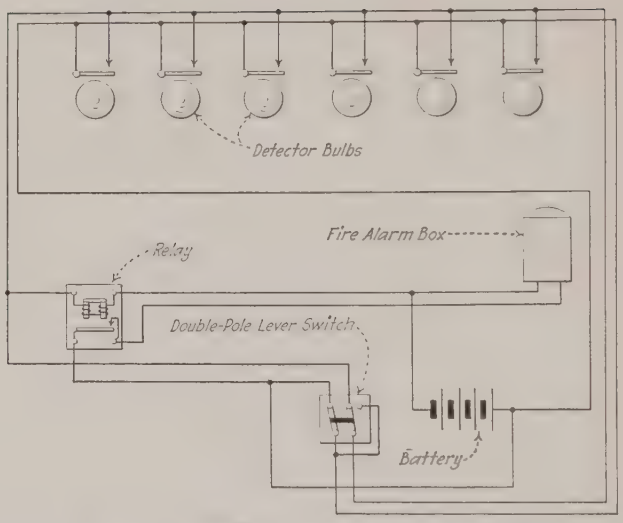


Fig. 235.—Diagram of an automatic fire-alarm system. The alarm circuit is normally open. A rapid rise in the atmospheric temperature causes the air in the detector bulbs to expand, thus forcing a diaphragm to close the alarm circuit. While a real fire causes a rise in temperature at the rate of 15 to 30 degrees a minute, it requires only a rise of 5 degrees a minute to operate the detector bulbs. Relatively gradual changes in temperature, such as are brought about by the heating of a building, do not affect the apparatus. (Metropolitan Electric Protective Co., 30 West 26th Street, New York.)

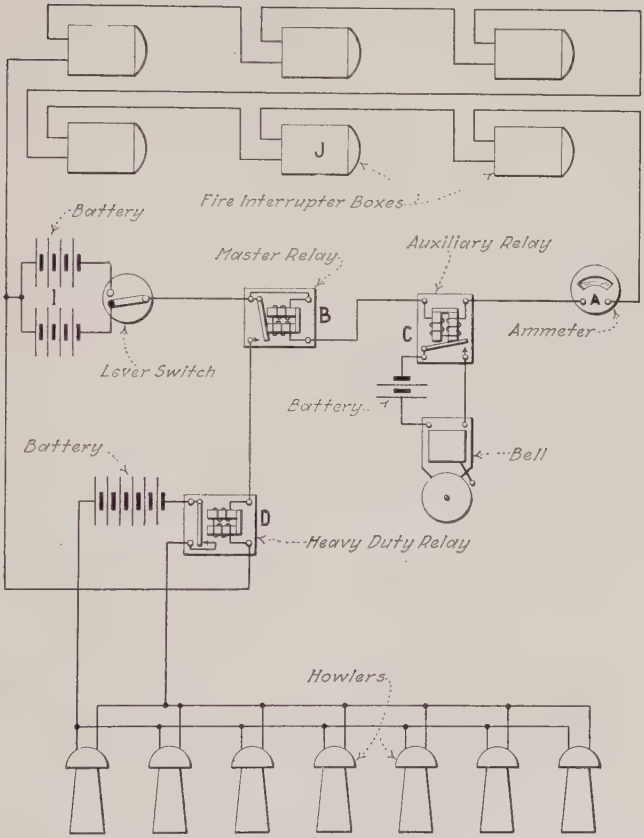


FIG. 236.—Diagram showing the connections of a multiple arrangement approved, interior fire-alarm installation using closed circuit call, or interrupter boxes, wired in series. The interrupter circuit includes an ammeter *A*, a trouble relay *C*, a master relay *B*, a battery *I* and the interrupter boxes *J*. When a fire alarm is sent in from one of the call boxes, the primary circuit is interrupted as many times as the number of the box indicates. (BENJAMIN INDUSTRIAL SIGNALS, *Bull.* 53.)

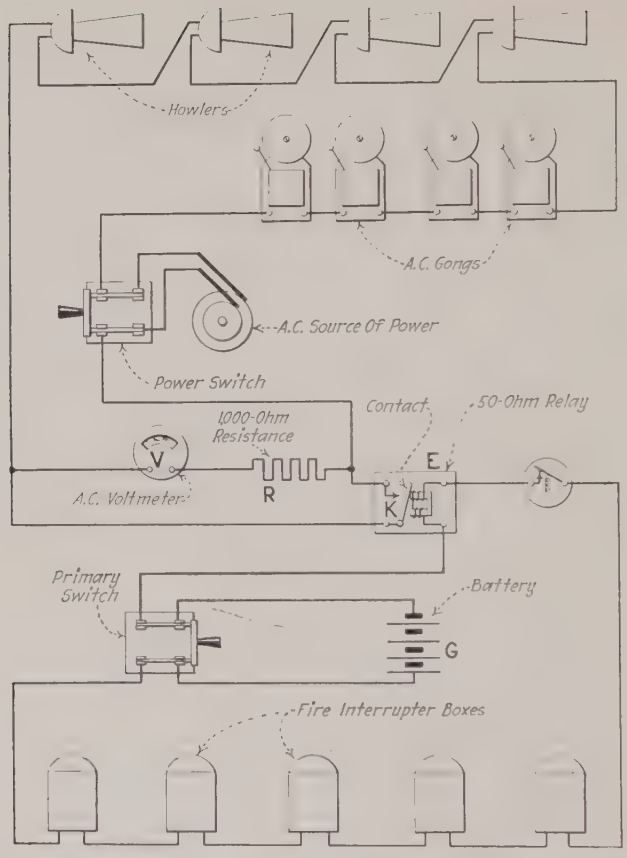


Fig. 237.—Wiring diagram of an alternating-current industrial fire-alarm installation. With the circuit in normal condition, relay E is energized by a battery G, which should be of an approved closed-circuit type, in series with the fire interrupter boxes. As long as the relay is energized, the contact K is open, hence the operating current energy is deflected through an external resistance R and an alternating-current voltmeter V to the howlers and gongs. The voltmeter indicates at all times if the signal circuit is in operating condition. When an alarm is sent in, relay E operates in unison with the call box interrupter. Each time the relay acts, the signal circuit is closed through contact K. (Benjamin Industrial Signals, *Bull.* 53.)

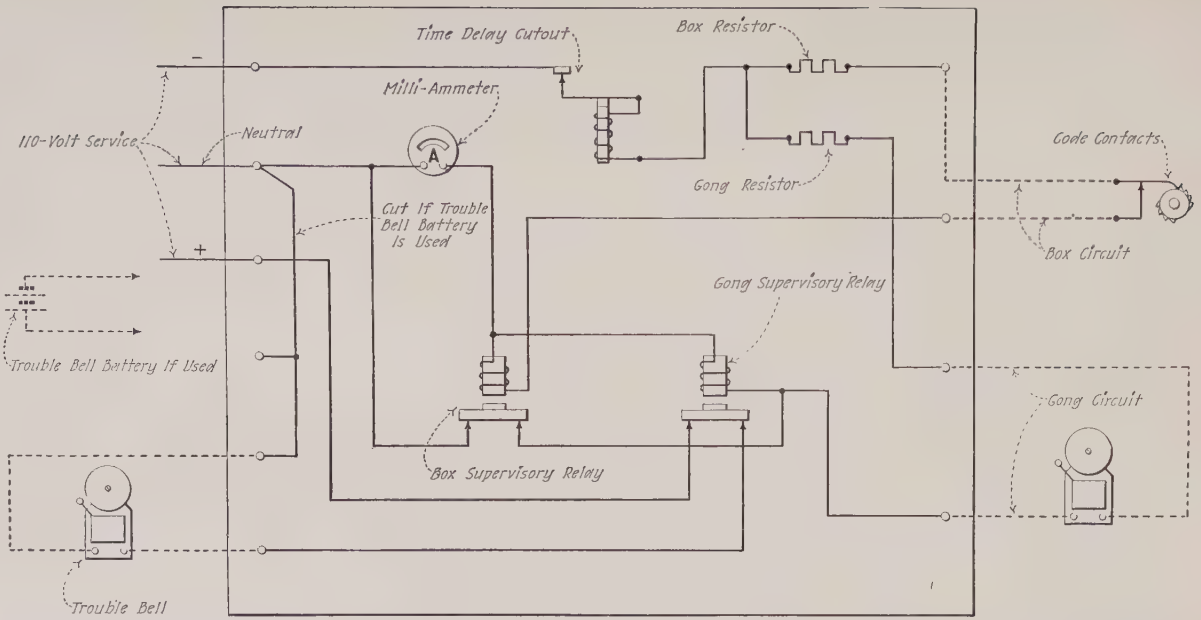


Fig. 238.—Schematic diagram of a closed-circuit general-alarm fire-alarm system operable on 110–220 volts alternating current, or direct current or battery. A time-limit delay cutout switch, which operates on the thermostatic principle, is employed. It can be set to automatically cut off the current at any given time (from 3 to 5 min.) should an excess amount of current flow through any circuit due to short circuits or grounds. (Signal Engineering and Mfg. Co., 533 Canal St., New York.)

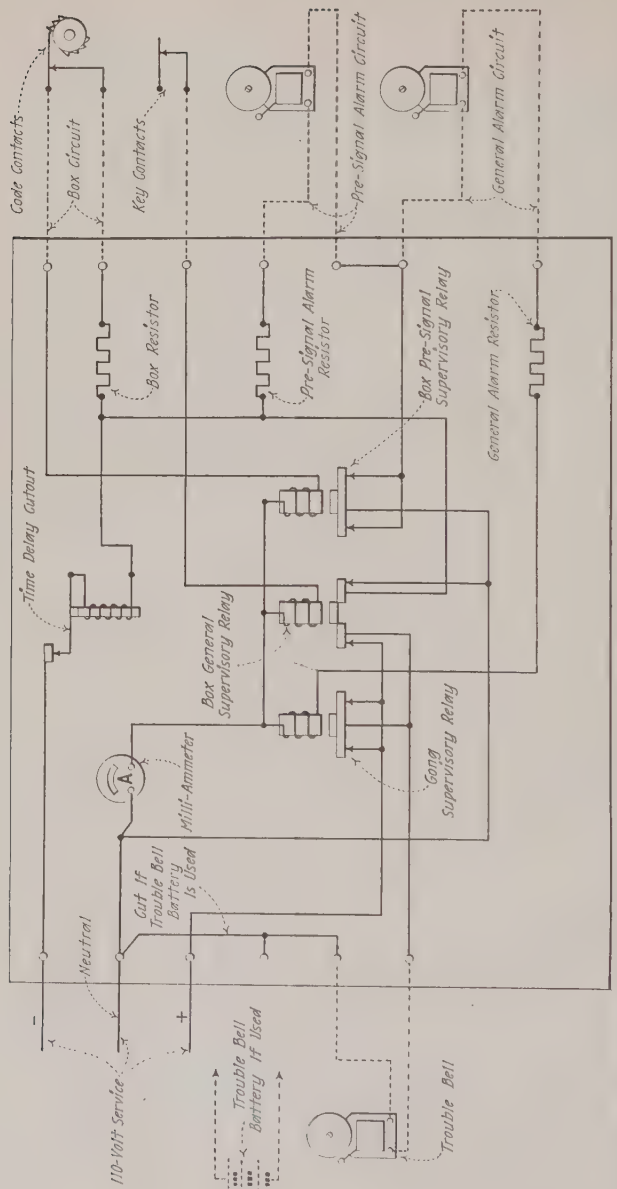


FIG. 239.—Schematic diagram of a closed-circuit preliminary-signal fire-alarm system. This system is designed for use in stores, hotels and hospitals where it is not desirable to sound the general alarm signals unless there is an actual fire which is serious enough to necessitate a general alarm and thus empty the building. The system is provided with two alarm circuits. When a transmitting station is pulled, it operates the signal devices on the preliminary alarm circuit, indicating the number of the station from which the alarm was sent. The preliminary alarm signals can be located in the office of the fire warden or within hearing of other persons having authority to investigate the cause of the alarm. In case of actual fire of such proportions as to endanger the occupants of the building, a key is inserted into the station, the lever pulled again, thus causing all signals on the general alarm circuit to operate. (SIGNAL ENGINEERING AND MFG. CO., 533 Canal St., New York.)

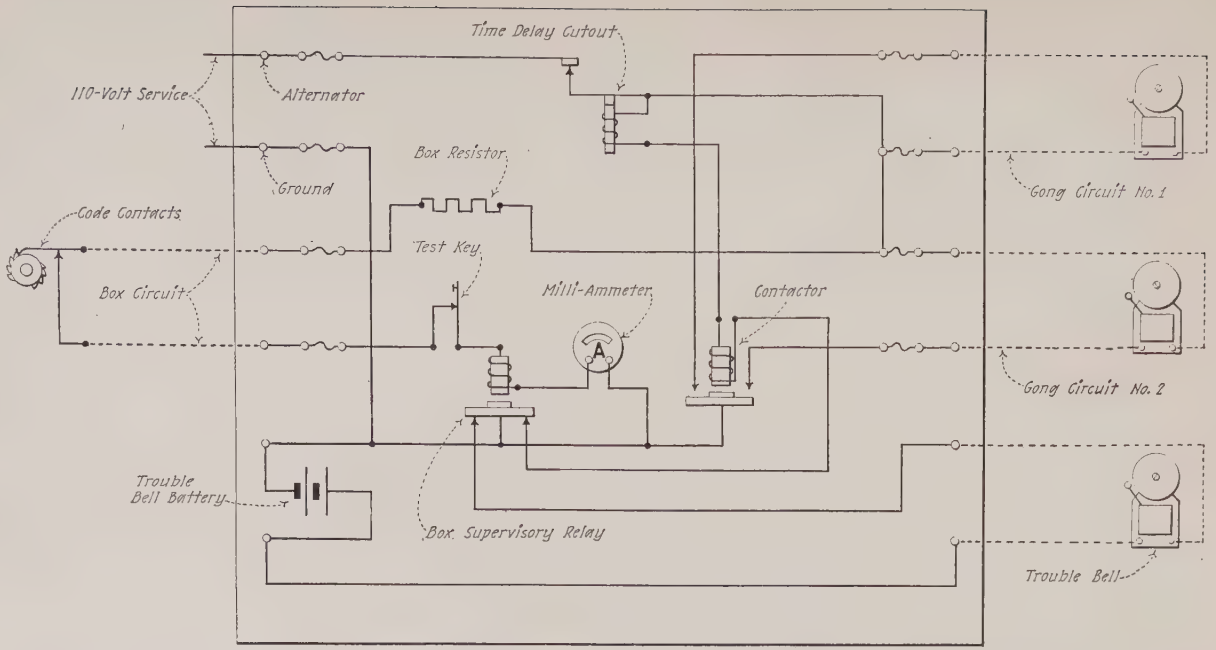


Fig. 240.—Schematic diagram of a general-alarm series-supervised box circuit, multiple-signal fire-alarm, system. The boxes are wired in series on a supervised circuit. The signals are installed in multiple on non-supervised circuits. In the event of a ground or open in the box circuit, it causes the trouble bell and all signals to operate for a period of three minutes. The time delay cut-out then operates; opening all circuits except the trouble bell which continues to sound the trouble alarm. All circuits are fused except the trouble bell circuit. If the *hot* side of the signal circuits becomes grounded, the fuse will blow and sound the trouble alarm. (Signal Engineering and Mfg. Co., 533 Canal St., New York.)

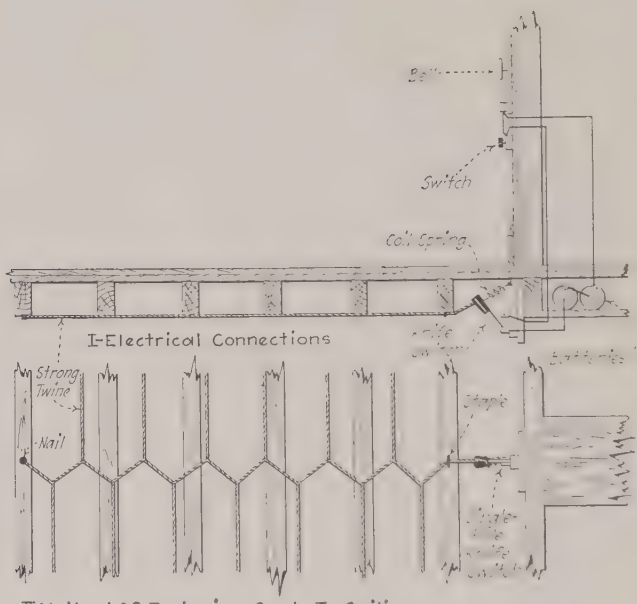


Fig. 241.—An improvised method of equipping a basement, garage or barn with a dependable fire-alarm system. Between the rafters or studding a heavy cord is stretched, one end of which is fastened to a switch. A strong spring is fastened to the switch which tends to close the switch. The connection is held open by the cord. Cords are connected to the main cord laterally across the room. These lateral cords are tightened in such a way as to leave the main cord in a zig-zag course as shown in *II*. Should a fire occur in any part of the space provided with this cord arrangement and any one of the lateral cords burned or broken, it will immediately release enough of the main cord to close the switch, which closes an alarm circuit and sounds a signal. (*Science and Invention*, Feb., 1924.)

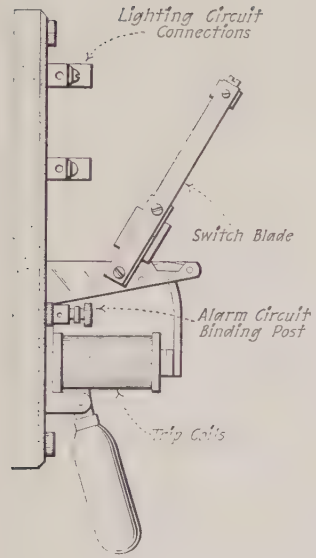


FIG. 242.

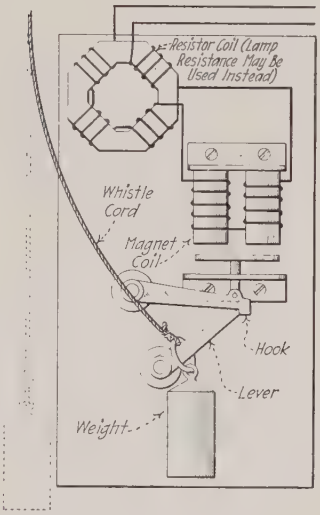


FIG. 243.

FIG. 242.—Illustration of an automatic electric light emergency switch. These switches are especially used in connection with fire-alarm systems. The low-voltage *trip coil* is connected into the alarm circuit and closes its circuit when the alarm operates, lighting the engine house. They save the expense which is involved in keeping lights burning all night. (S. A. STEWART AND CO.)

FIG. 243.—Fire or warning whistle operated by an electrically released weight. This is operated from a 110-volt lighting circuit. A switch, which is located in the telephone exchange or other suitable place, is closed when it is desired that the whistle be blown. Closing this switch permits the 110-volt current to flow through the magnet coils, releasing the weight and blowing the whistle.

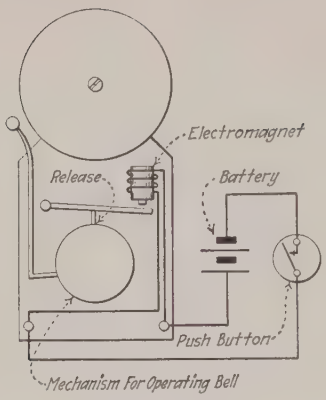


Fig. 244.

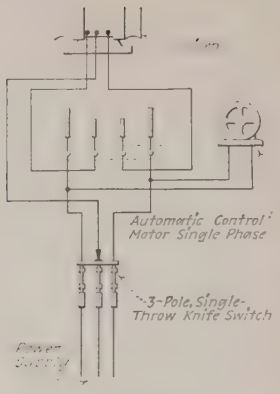


Fig. 245.

Fig. 244.—Diagram of an electrically-released mechanically-operated bell. This type of bell is usually used on fire alarm circuits.

Fig. 245.—Wiring diagram for a Sterling electric siren, using a three-phase motor with an automatic control. An automatic single-phase-control motor operates a rotary switch, which keeps the sound of the siren up and down the scale after the switch has been closed. (The Inter-state Machine Products Co., Rochester, N. Y.)

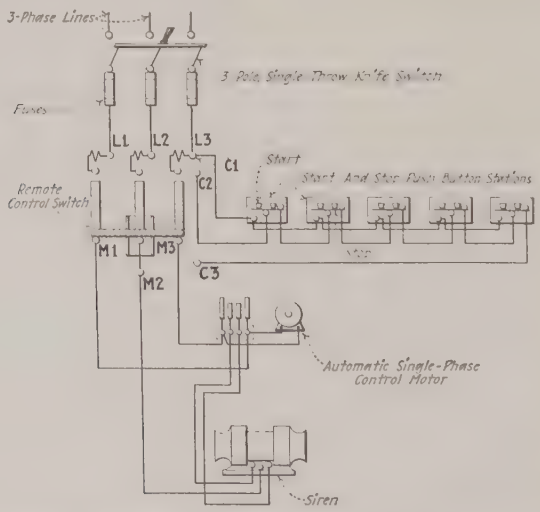


Fig. 246.—Wiring diagram for a Sterling electric siren operated by a three-phase motor having automatic and remote-control start and stop stations. An automatic control single-phase motor operates a rotary switch which keeps the sound of the siren running up and down the scale. (Inter-state Machine Products Co., Rochester, N. Y.)

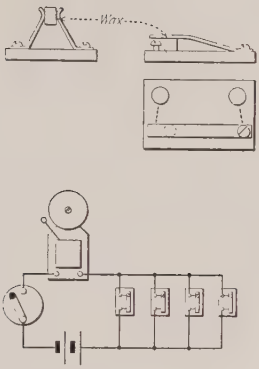


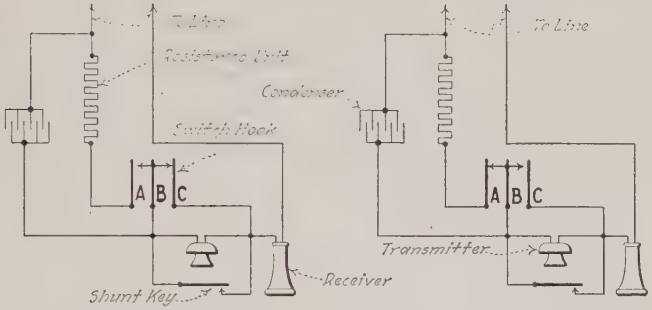
Fig. 247.—Home-made fire-alarm device.

DIVISION 8

WATCHMAN AND POLICE-CALL CIRCUITS

DIVISION 8

WATCHMAN AND POLICE-CALL CIRCUITS



I - Arrangement Of Hummer Circuit When Receiver Is On Hook.

II - Wiring Diagram Of Talking Circuit When Receiver Is Off Hook.

FIG. 248.—Diagram of the various circuits in the police-signal box with the receiver hook up and down. A signal can be sent to the patrolman from the operator, while the patrolman is at the box and the receiver is on the hook. This signal consists of a low frequency *hummer* signal in the receiver. In *II* the circuit is diagramed when the receiver is off the hook. (*Electrical Review and Western Electrician*, March 3, 1917.)

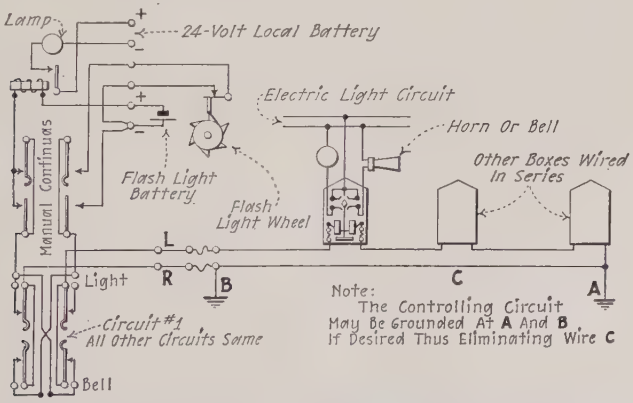


FIG. 249.—Wiring diagram of a flash-light and horn signal circuit on a police-signal system. Visual and audible signals are placed on each circuit, consisting of a green light at night and a horn during the day time. The energy for the signals is carried over a separate circuit and is controlled by a polarized relay in the call boxes. (*Electrical Review and Western Electrician.*)

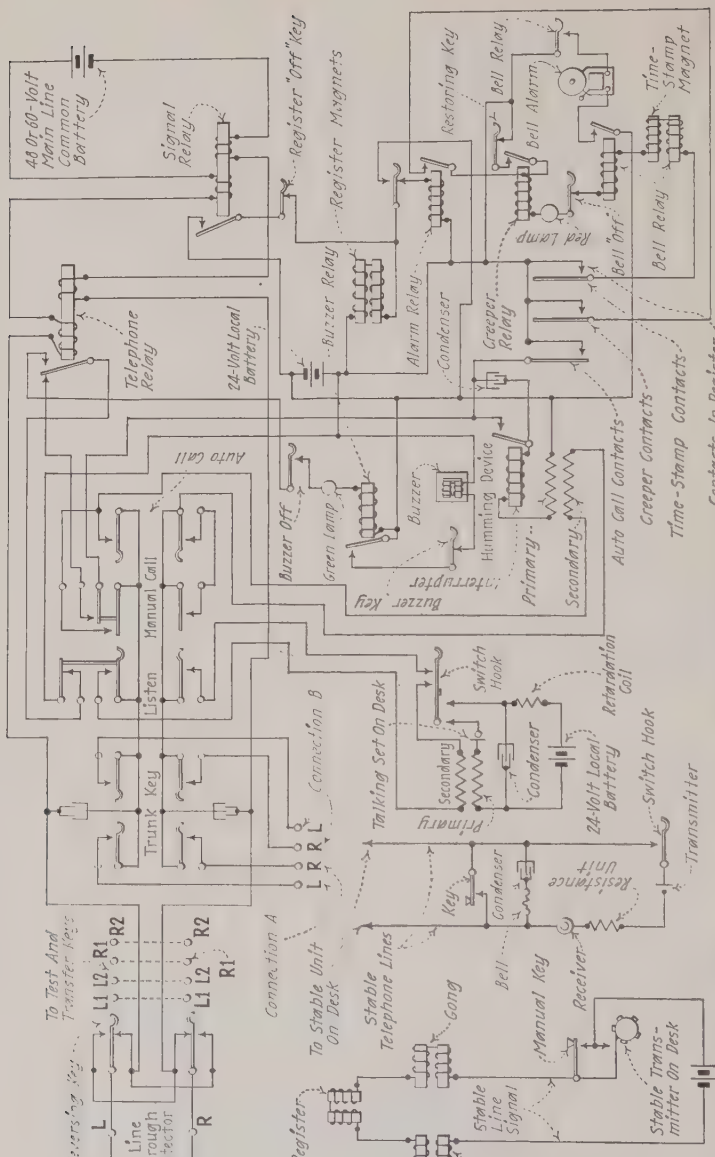


FIG. 250.—Wiring diagram of a police-signal operating switchboard. (*Electrical Review and Western Electrician*, Mar. 3, 1917.)

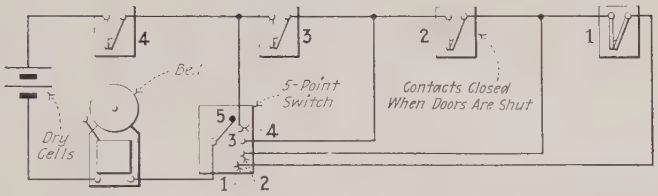


FIG. 251.—A night watchman's signal circuit. The watchman can determine whether all the doors are closed by placing the lever switch on the various contacts connected to the doors throughout the building.

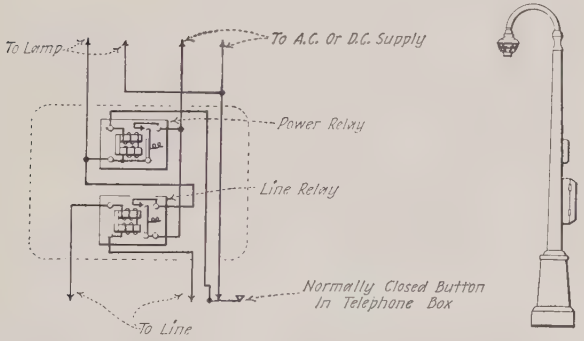


FIG. 252.—Wiring diagram of police-call signal relays. (SIGNAL ENG. AND MFG. CO., New York.)

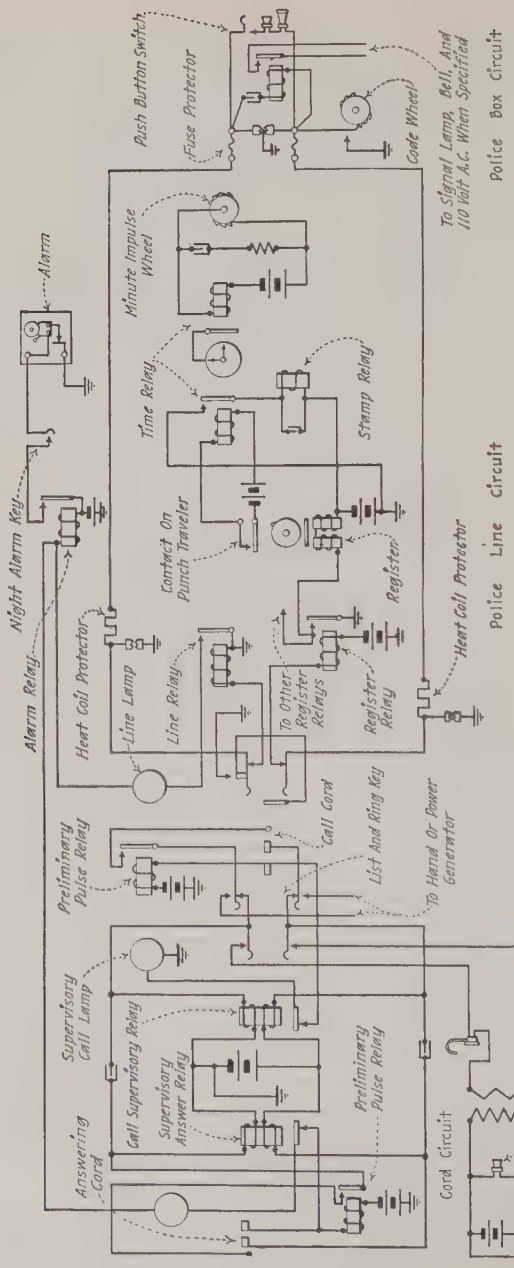
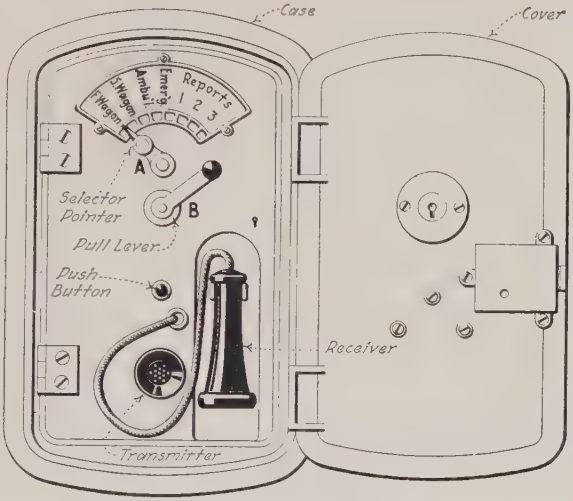
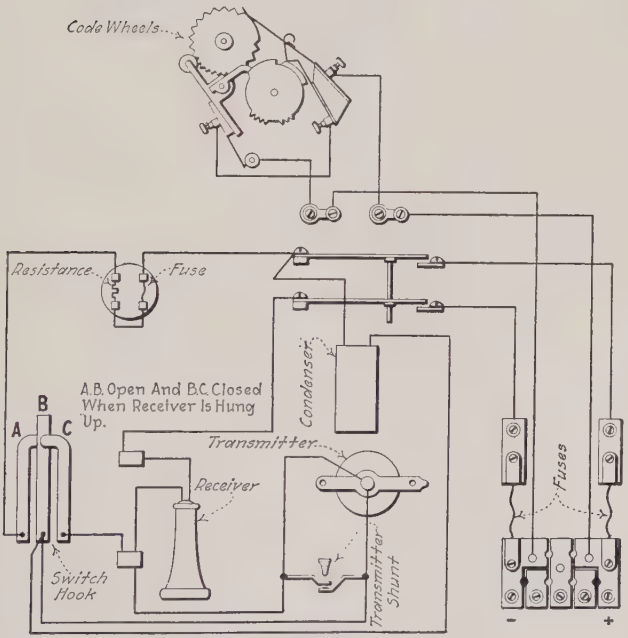


FIG. 253.—Schematic wiring diagram of a police-signal circuit.



I- Street Signal Box.



II- Wiring Diagram.

FIG. 254.

FIG. 254.—Wiring diagram for a street box used on a police-signal system. The box is equipped with a telephone and a code-sending device. It is provided with four emergency calls and three officers's report calls. As shown in *I*, these calls are selected by the patrol man by moving the arrow-shaped selector, pointer *A*, to the call desired and pulling the operating lever, *B*, clear down and releasing it, which sets the code-sending device into operation. A signal is thereby transmitted to the central station notifying the operator of the call from the patrolman. (*Electrical Review and Western Electrician*, March 3, 1917.)

DIVISION 9

POWER-STATION SIGNALLING

DIVISION 9

POWER-STATION SIGNALLING

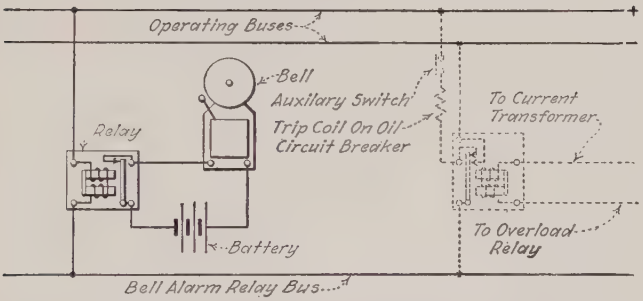


FIG. 255.—Diagram of the connections of a bell-alarm relay switch for a power switchboard circuit-breaker. The bell-alarm signal circuit is independent of the circuit-breaker trip coils.

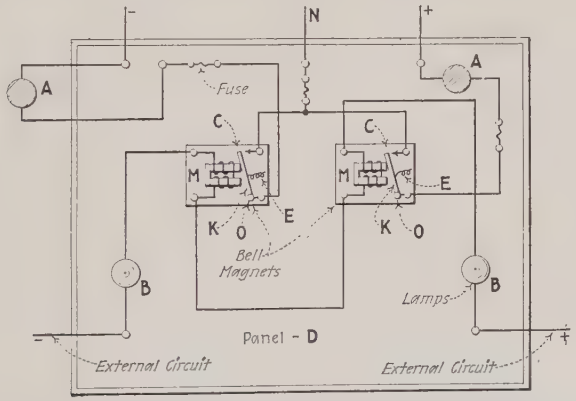


FIG. 256.—Diagram of connections of a circuit-breaker indicator. Two bell magnets *M* and *M*, are connected in series across the two outside lines of the system, with the lamps, *B*, limiting the current to about ½ amp. The keepers, *K*, are made of light pieces of iron with a flexible joint at *O*. Light springs, *E*, are connected to the keepers holding contact points *C* closed when magnets *M* are de-energized. The lamps *B* are mounted on the panel *D* and burn as long as the circuit is complete through the magnets *M*. If the circuit through the external circuit is interrupted, the magnets *M* are de-energized and the keepers *K* are released closing contacts *C*. A circuit is thereby completed through the lamps *A* which light and remain so until the breaker is closed. These lights are located at any conspicuous points around the plant. (*Power Plant Engineering*, Aug. 15, 1919.)

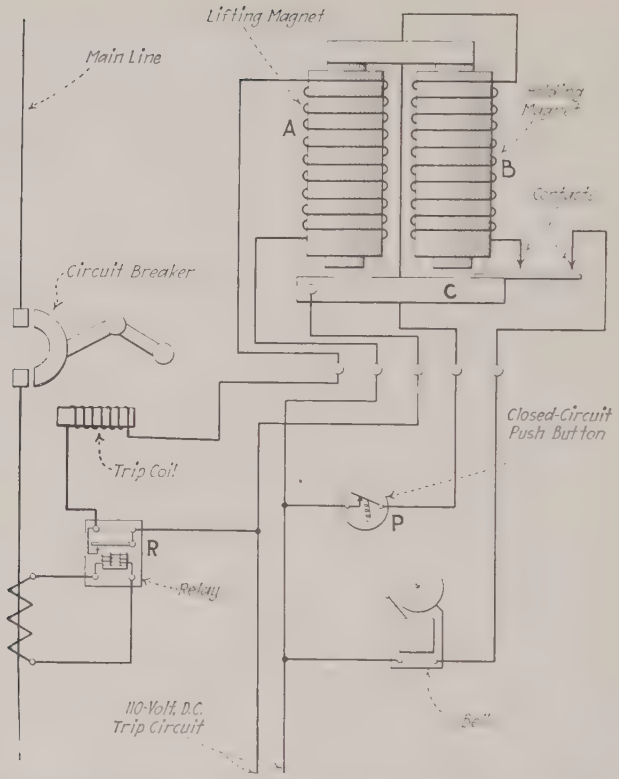


Fig. 257.—Circuit diagram of a circuit-breaker alarm. Electromagnet *A* is in series with the tripping circuit of the breaker, so that when the relay *R* closes this circuit, this magnet attracts the armature *C*, which in turn closes two circuits, one through the electromagnet *B* and one through an external bell. Electromagnet *B* prevents the armature *C* from dropping, even though the electromagnet *A* should become de-energized by the breaker opening, thus keeping the contacts closed and ringing the bell until notice is taken. The bell is stopped by breaking the circuit through the electromagnet *B*, by pressing push button *P*. An alarm is not sounded when the circuit breaker is opened by hand. (*Southern Engineer.*)

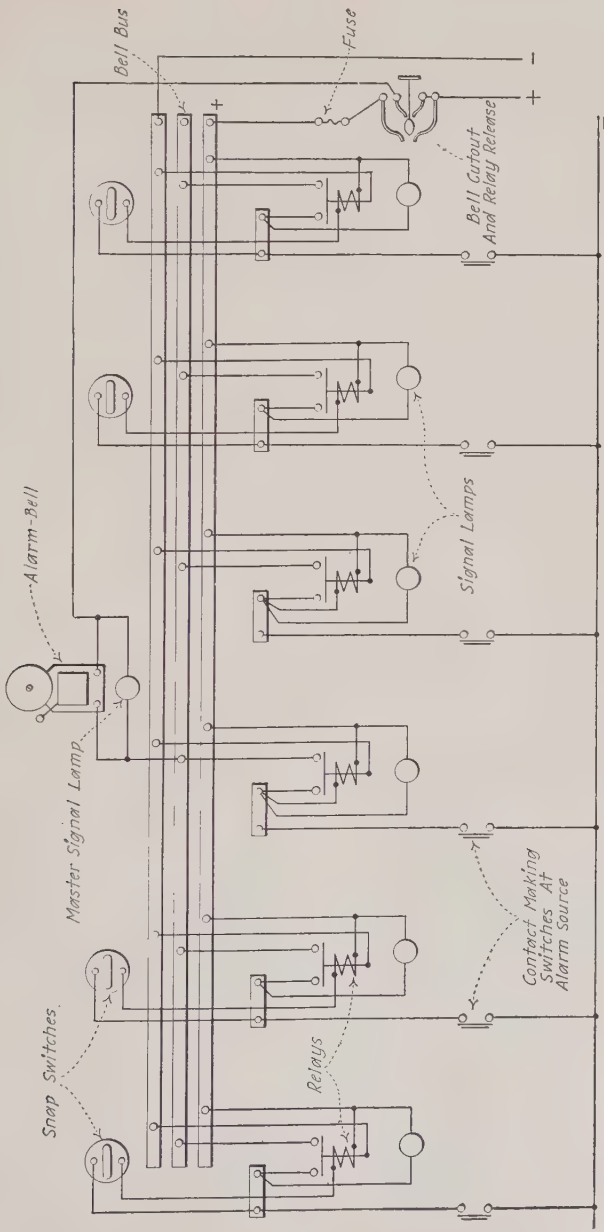


FIG. 258.—An annunciator power-switchboard signaling system which warns the station operator of each and every switch which "kicks out" in case of trouble—any high temperature on transformers, generators or condensers or the accidental grounding of an ungrounded system. (CALIFORNIA EDISON CO., Los Angeles.)

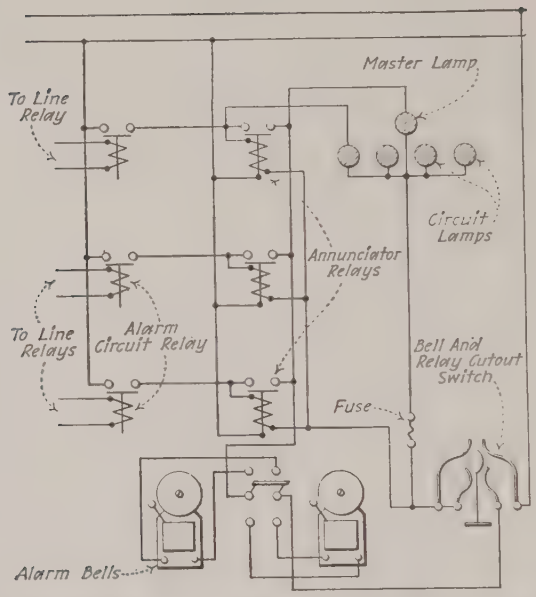


Fig. 259.—Desk-type power-switchboard annunciator signal system used by the California Edison Co. If an oil switch trips out, the alarm circuit relay, which is actuated by the line relay, operates a trip relay and also a second relay. The latter relay closes one circuit which closes an alarm and another circuit which lights two lamps in the annunciator. One of these gives a red pilot light connected common to all relays, while the other gives a white light which indicates the cause of the trouble. The cut-out switch has three positions, it is normally in the central position. When the alarm bell rings, the operator pulls the switch forward which cuts out the bell alarm. When he has ascertained the cause of the trouble, he pushes the switch to the back position which restores the relays to their normal positions, with the exception of the temperature relays, which require the thermostats to return to their normal temperatures before the relays will be restored. (*Electrical World*, Jan. 7, 1924.)

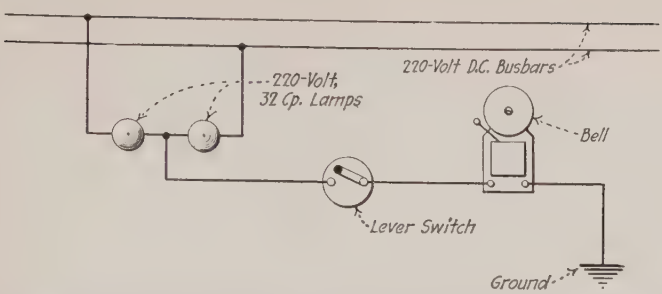


FIG. 260.—Diagram of a lighting-circuit alarm which gives a warning when the lighting circuit becomes grounded. The vibrating bell must be one designed for high-voltage operation. (*Industrial Engineer*, March, 1923.)

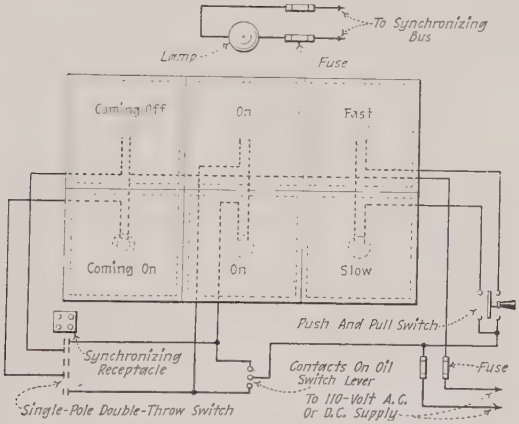
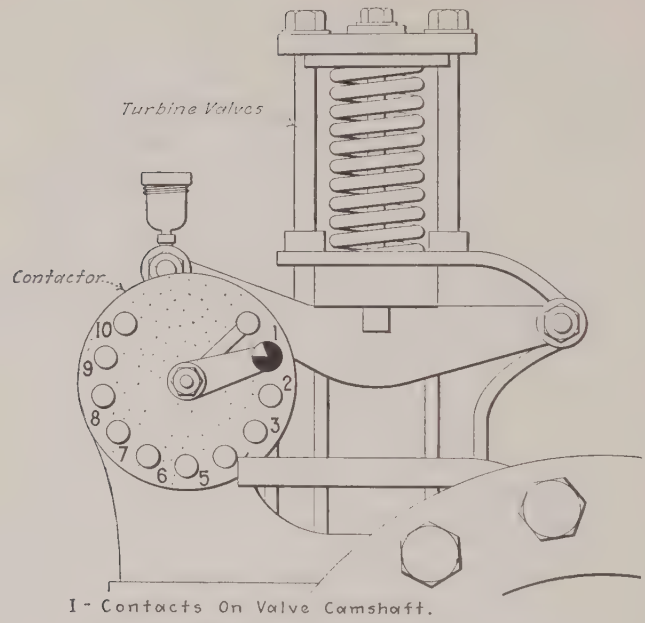
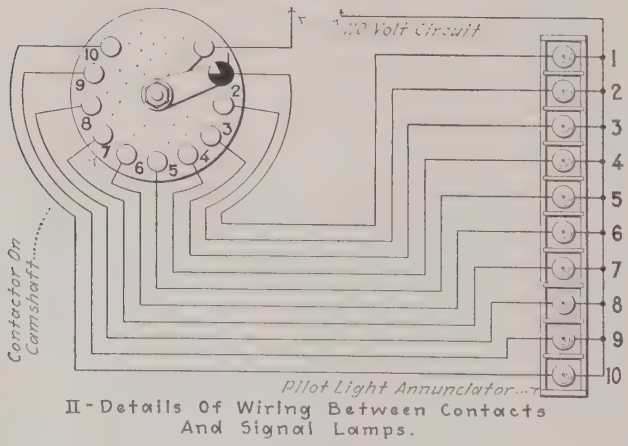


FIG. 261.—Wiring arrangement for an engine-room signal. A box is provided which has six lamp signal compartments. The signal words are painted on tracing cloth just large enough to cover the front of the box. The box is mounted on the top of the gage board, where it can be plainly seen by the man at the engine throttle. Two contacts, which are connected to the signals "On" and "Off," are mounted on the generator oil switch. A pull and push switch, normally open, is mounted on the generator panel and connected to the signals "Slow" and "Fast." Below the synchronizing-plug receptacle, a single-pole, double-throw switch is mounted, the handle of which, when in the up position, will prevent the plug from being inserted. This switch is connected to the "Coming on" and "Coming off" signals, so that in throwing down the switch the engineer is notified that the operator is ready to synchronize. This switch is mounted in such a manner as to compel the switchboard operator to notify the engineer before he synchronizes. A synchronizing lamp is mounted above the signal box which permits the engineer to bring the engine to the proper speed by watching the pulsations of the lamp. (*Electrical World*, Oct., 1917.)



I - Contacts On Valve Camshaft.



II - Details Of Wiring Between Contacts And Signal Lamps.

Fig. 262.

Fig. 262.—Diagram of an automatically operated steam-turbine load-signalling arrangement which indicates, to the fireman, the number of valves open on a steam-turbine electric unit. In the boiler room is an indicating board, Fig. *II*, on the front of which is a glass cover upon which are painted figures from 1 to 10. Back of each figure is a lamp. The figures indicate the number of valves open on the turbine. When one valve is open, the figure "1" is illuminated, if four valves are open, the figure "4" is illuminated, and so on up to "10," thus showing the fireman how many steam valves on the turbine are open. He then can control his fires accordingly. This automatic illumination is produced by a home-made arrangement that is attached to the steam valve camshaft of each turbine. A contact head carrying ten insulated contacts is mounted to the camshaft support. A contactor arm is attached to the camshaft. The contacts and lamps are connected as shown in the wiring diagram in *II*. (*Power*, June 19, 1917.)

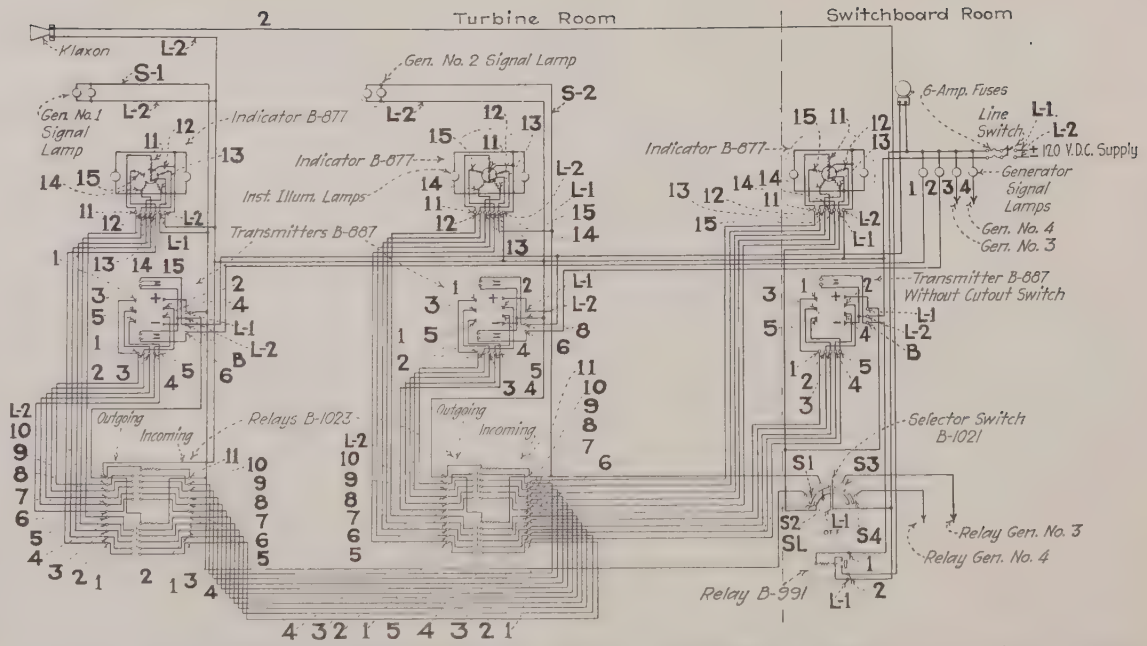


FIG. 263.—Wiring diagram for a turbine-order signal system. These systems are used for communicating routine instructions between the switchboard room and the turbine room of a modern power plant. (CHAS. CORY & SONS, INC.)

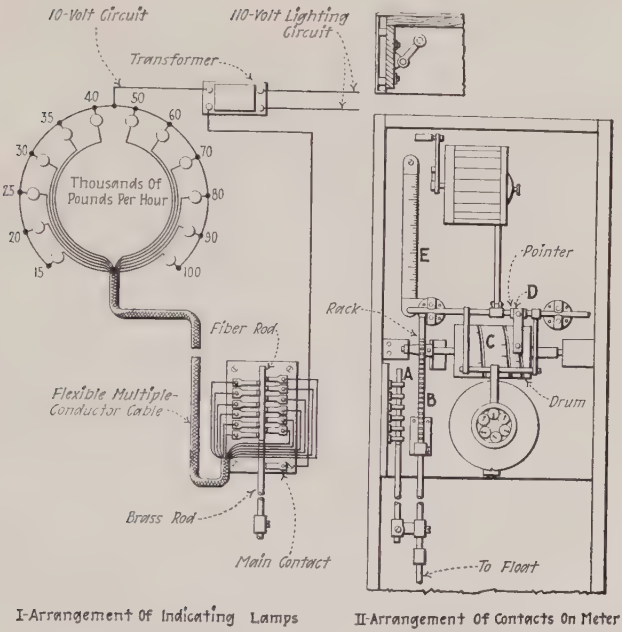


FIG. 264.—Diagram of boiler-room load indicator operated from metering feed-water heater. A rod ⅜ in. in diameter and sliding through a series of contacts was fastened to the rack as shown in *II*. The top portion of the rod was made of fiber and the lower portion of brass. In locating the contacts on the board, the rack *B* was raised and as the various rates of flow marked on the drum *C* coincided with the pointer *D*, a corresponding mark was made on the scale *E*. The contacts were then spaced accordingly and connected to a series of 10-volt lamps arranged on a board conveniently located in the boiler room in plain view of the fireman; a transformer is connected to the lighting circuit to provide a low voltage for the lamps. Multiple conductor cable was used to make connections between the contacts and lamps. (*Power*, July 22, 1924.)

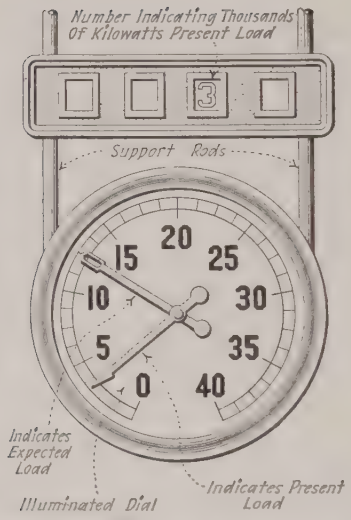


Fig. 265.—Illustrating a central-station load indicator. The numbers on the dial indicate the number of thousand kilowatts. One pointer indicates the present load and the other the expected load.

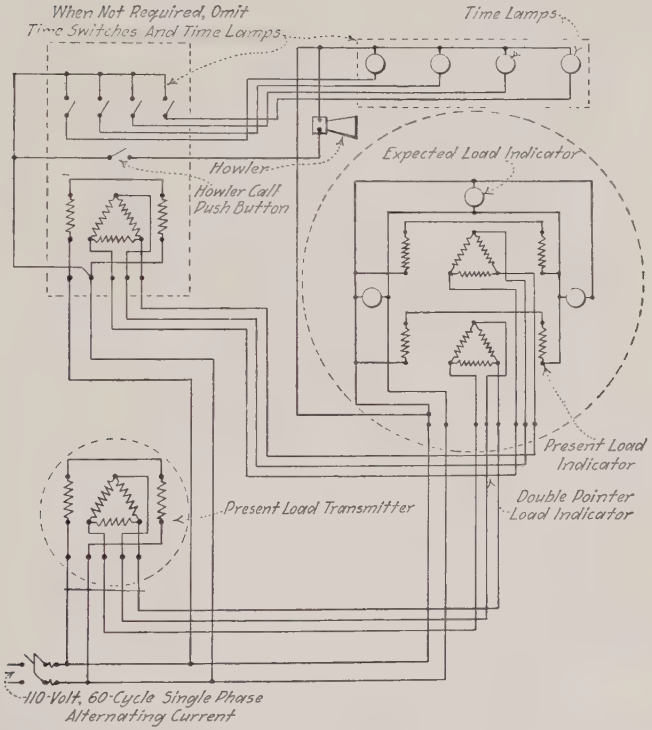


Fig. 266.—Wiring diagram of an alternating-current load-indicating system, which indicates to the turbine room the present and expected load. The present-load indicator is operated through a graphic wattmeter which is located on the switchboard in the switchboard room. The expected-load indicator is operated by the load dispatcher by means of suitable switches. (Chas. Cory and Son, Inc., N. Y.)

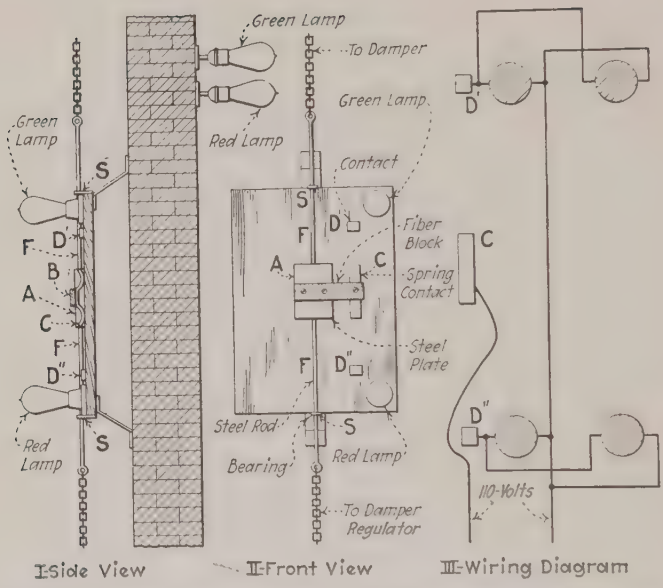


Fig. 267.—Damper regulator signal. By this arrangement, a visual signal indicates the position of the damper. A front view of the apparatus is shown in *II*. It consists of a board about 18 by 10 in. On a piece of steel *A*, 2- by 4- by $\frac{3}{8}$-in., is screwed a piece of fiber *B*, 4- by 1- by $\frac{1}{4}$-in. A spring-brass contactor *C* is screwed to the fiber strip. Steel rods *F*, *F*, $\frac{3}{16}$ in. in diameter are screwed into the steel plate *A*. These rods are supported by and slide through bearings *S*, *S*. Contacts *D'* and *D''* are fastened to the board as shown, and are connected to a green and red lamp respectively. A flexible wire connects the spring contact *C* with the line. When the damper is open, connection is made with the lower contact, and where the damper is closed, the upper contact is closed. In *I* is shown the device attached to the boiler room wall. As long as neither of the lamps are illuminated, it is evident that there is sufficient fire. However, should the red lamp remain lighted for several minutes, it shows that the fire needs attention. Since a set of these lamps is in the boiler room and a set in the engine room, either the fireman or engineer can keep a check on the boilers. (*Power Plant Engineering*, Nov. 15, 1918.)

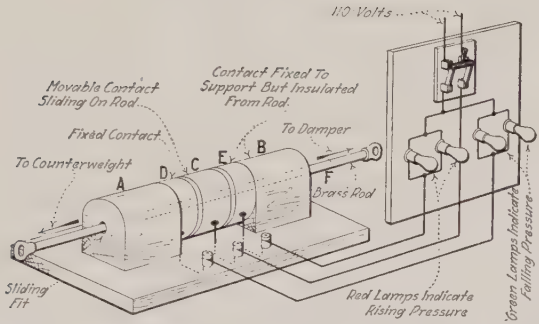
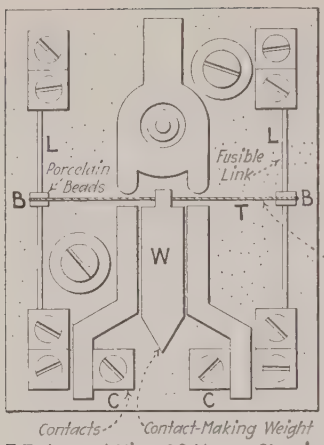
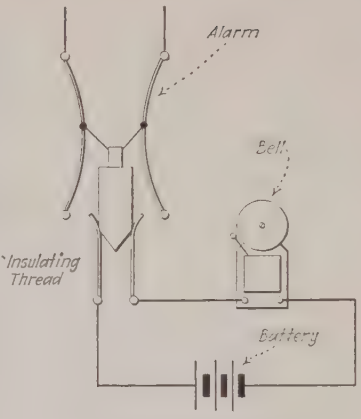


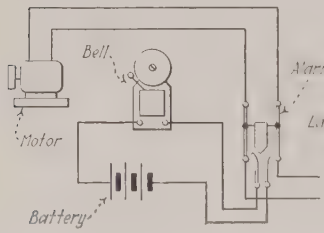
FIG. 267A.—Details of connections and construction of a damper signal. A brass rod *F*, slides through two wooden supports *A* and *B*, and is connected to the damper regulator by a chain. Riding on this rod, but free to move with slight friction, is a brass sleeve collar *C* serving as the movable contact. Fixed contacts *D* and *E* are fastened to the wooden supports *A* and *B*. *D* and *E* have a bore sufficiently large to permit the rod *F* to pass through without making contact with them. The connections are made as illustrated; the green lights indicate high pressure and the red lights low pressure. (*Power*, April 29, 1924.)



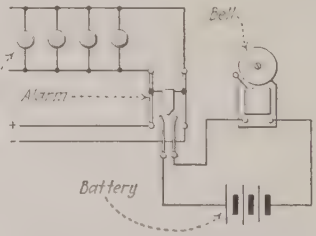
I-Enlarged View Of Alarm Showing Weight In Position Ready To Descend When Heat Is Encountered



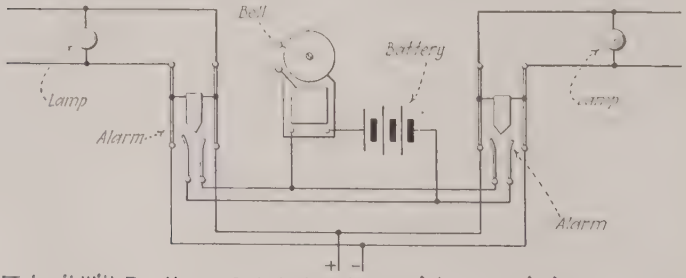
II-Diagram Showing How Softening Of The Fuse Wires Will Bring The Alarm Into Action Even Before They Melt



III-Alarm Used As A Protector Against Motor Overload



IV-A Set Of Lamps Are Shown Lit By The Current. When They Take Too Much Current The Alarm Will Ring



V-Circuit With Two Alarms So As To Guard Two Points In A Building

Fig. 268.

FIG. 268.—An alarm for short circuits and excess currents. The construction of the device is shown in *I*. A contact-making weight, *W*, is suspended above two contacts, *CC*, which are connected into an alarm circuit. The weight, *W*, is suspended by an insulating thread, *T*. The ends of the thread are fastened to two small porcelain beads, *BB*, which are supported by the two fusible links, *LL*. When either of the two links melt, due to an excessive current flowing through the circuit protected by the device, the weight, *W*, drops making contact across contacts, *CC*, which closes an alarm circuit. Various applications of the device are shown in *II*, *III*, *IV* and *V*. (*Popular Electrics*, Aug., 1923.)

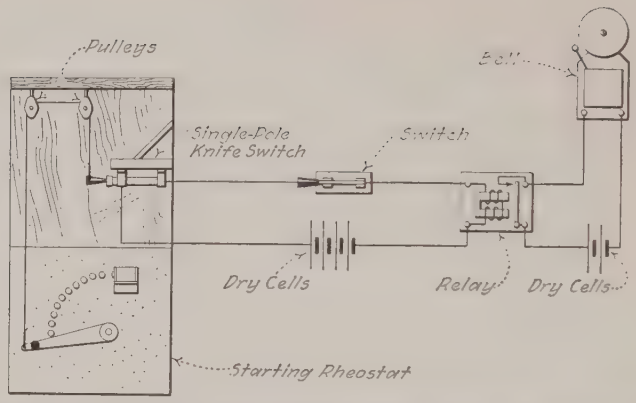


Fig. 269.—Diagram of an alarm system that signals when the motor stops. (*Practical Engineer*, Sept. 1, 1916.)

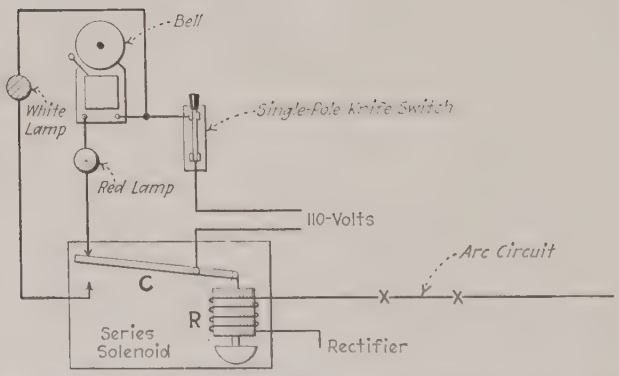


Fig. 270.—Wiring diagram of an alarm to indicate the operation of a remote rectifier set. The rectifiers were mounted in the basement of the station and the main operating floor was on the first floor. Since the station operator could not make sure that the rectifiers were working properly without running up and down the stairs at intervals, an alarm circuit, operated from a series solenoid *R* was arranged. As long as the rectifier operates properly the white lamp is lighted. If the arc circuit is interrupted the contact arm *C* drops to the bell circuit at the same time lighting a red lamp as a visual warning. ("Handbook of Electrical Methods," McGraw-Hill Book Company, Inc.)

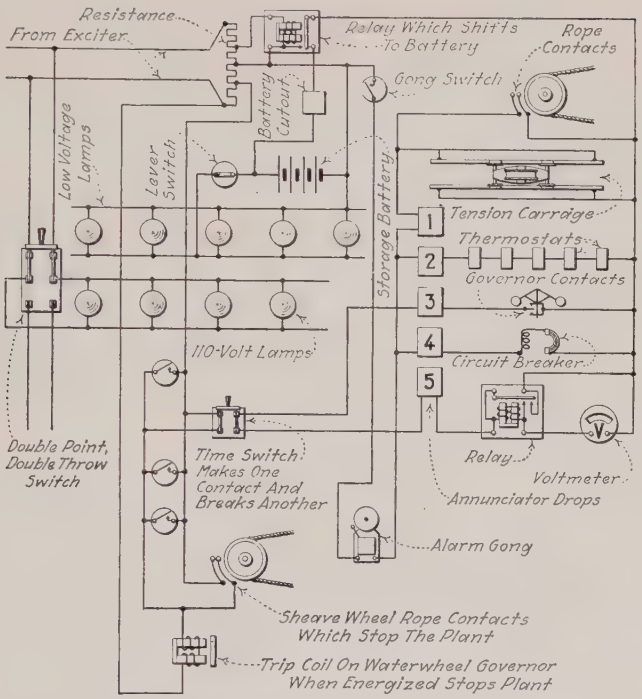


FIG. 271.—Diagram of connections for automatic indication of trouble in Boone N. C. hydro-electric plant. The plant was controlled automatically without the services of an attendant. Automatic arrangements are provided to shut down the plant in case trouble develops or abnormal operating conditions arise. An alarm is provided which sounds when the plant is shut down. The gong is placed on the outside of the station and can be heard by a mechanic in a near-by mill who is in charge of the station and responds to the alarm. An annunciator with five drops indicates the origin of any trouble that causes the alarm to be sounded. The drops show the following troubles: (1) *Frayed or broken ropes or belts, or tension carriage at the end of track.* (2) *One or more hot bearings or overloaded generator; all bearings and generator are equipped with thermostats.* (3) *Speed above or below normal, indicated from governor.* (4) *Automatic oil switch tripped.* (5) *Voltage above or below normal.* The current for the operation is normally taken from a shunted Nichrome resistance on the exciter buses. After the exciter has stopped, a relay shifts the alarm circuit to a storage battery. The circuit through the governor contacts is carried through a time switch so that when the plant is closed down at midnight and the governor comes to rest, the alarm will not be sounded. (*Electrical World*, July 29, 1916.)

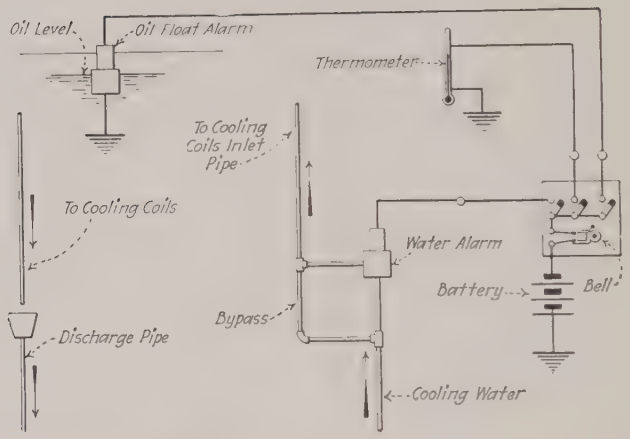


Fig. 272.—Alarm connection for transformer. Alarm circuits are provided for detecting abnormal rise in temperature, failure of cooling water supply, or lowering of oil level. By this arrangement the operator can test his oil, water and temperature without leaving his position. ("Handbook of Electrical Methods," McGraw-Hill Book Company, Inc.)

DIVISION 10

WATER-FLOW AND PRESSURE ALARMS

DIVISION 10

WATER-FLOW AND PRESSURE ALARMS

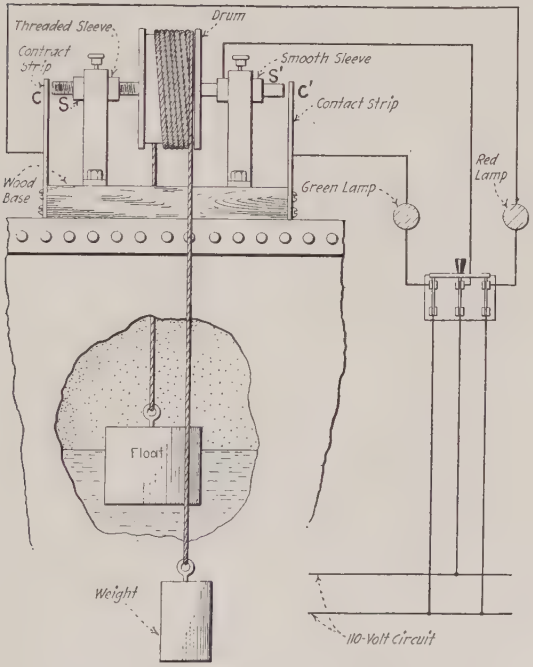


FIG. 273.—High- and low-water-alarm float switch. When the level of the water in the tank is at its upper limit, the threaded sleeve S' contacts with contact C' thereby closing the circuit through a green lamp. When the water is at its lower level, threaded sleeve S contacts with contact C which completes the circuit through the red lamp. The lamps serve as signals in determining when the water level is *high* or *low*. (*Industrial Engineer*, June, 1923.)

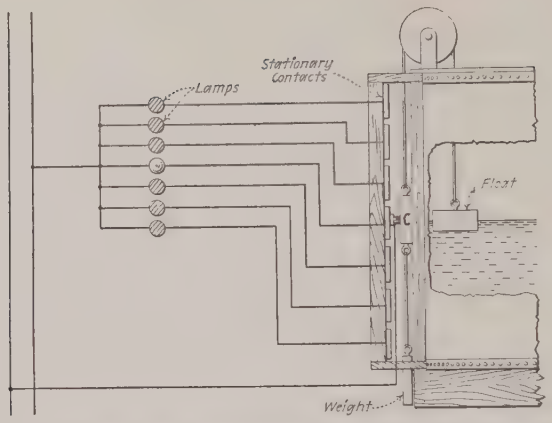


Fig. 274.—A float-and-lamp arrangement for indicating the level of water in a tank. A movable contact *C* is controlled by a weight and float. The contact closes the lamp circuit, indicating the various levels of the water. (*Industrial Engineer*, March, 1924.)

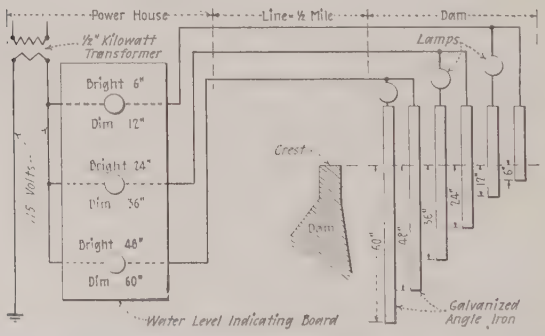


Fig. 275.—Diagram of a water-level indicator. By this arrangement, the elevation of the water in the dam of a small hydro-plant can be accurately determined. The water level in the dam is indicated by the brightness of the various lamps on the indicating board. At the dam six pieces of galvanized iron are rigidly mounted on a stationary wooden frame work; the lengths are shown in the illustration. (*Electrical World*, Mar. 31, 1923.)

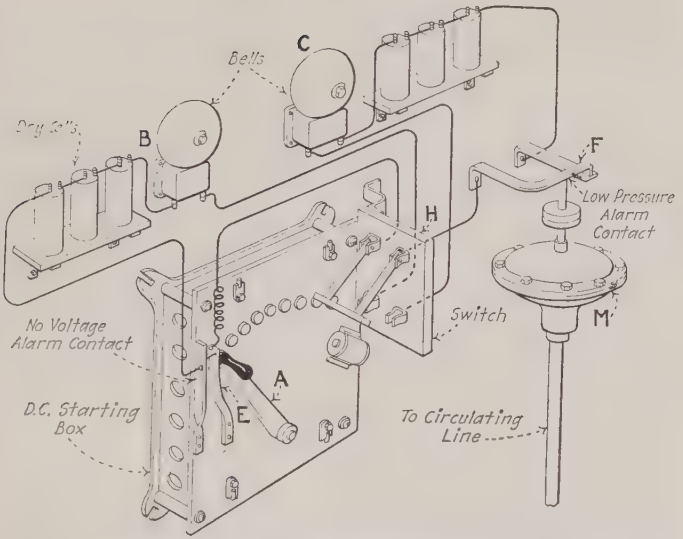


Fig. 276.—Wiring diagram for a double-circuit alarm circuit for a circulating-water system. In the double-alarm arrangement shown, two separate circuits are used. If the power circuit opens, the starting box lever *A* will close the contact *E*, causing the bell *B* to ring. When the pressure in the circulating line drops, the contact *F* will close and the bell *C* will ring. A two-pole switch *H* is placed in such a position that it can be opened to stop the bells from ringing, but cannot be left open by mistake, because the switch is placed so that the end of the lever *A* pushes the switch closed before the end of travel. An ordinary diaphragm regulator is connected to the pressure line and closes the alarm circuit at the proper pressure. (*Power*, Mar. 4, 1924.)

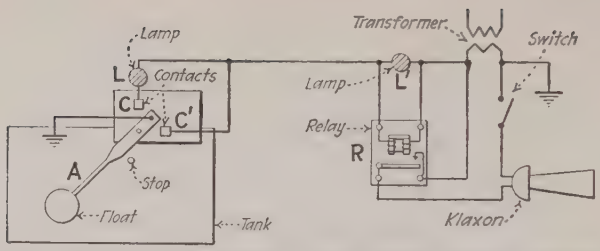


Fig. 277.—Diagram of a tank signal (high- and low-water) and alarm. The current is supplied through a 100-watt potential transformer which has its primary connected to the 2200-volt bus and one side of the secondary grounded. The movable arm A on the tank is also grounded. When the tank is full, the float arm A makes contact with contact C' and lamp L', at the station, lights brilliantly. When the water in the tank is at a very low level, contact C is closed to the float arm A closing the circuit through lamps L and L' in series, lighting lamp L dimly. The operator at the station is thus informed of the level of the water in the tank by the lighting of the lamp. A relay is connected across lamp L', which is energized when the lamp is lighted. This relay closes a Klaxon circuit which attracts the attention of the operator. (*Power Plant Engineering*, August 15, 1922.)

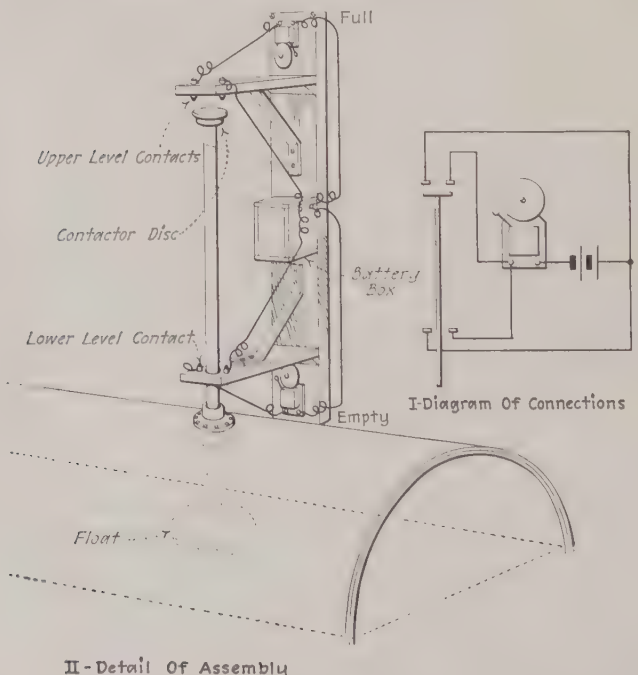


Fig. 278.—A high- and low-water alarm on a house supply tank. (*Power*, Mar. 5, 1918.)

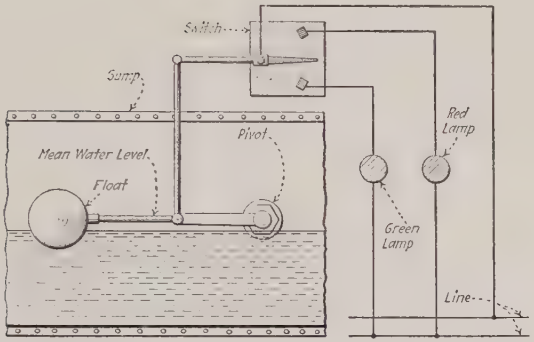


FIG. 279.—Colored-light signal indicating high- and low-stage of water in a cooling-tower sump.

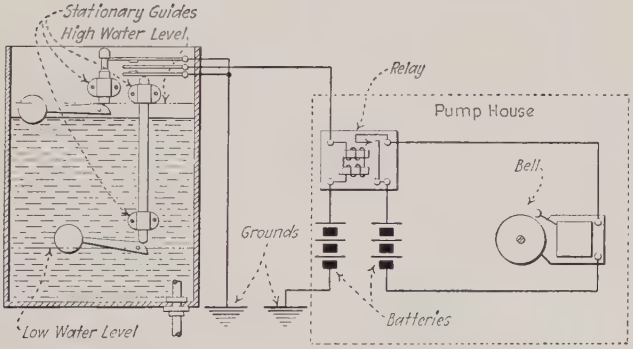


FIG. 280.—Another water-tank level alarm. A separate float is provided for actuating the alarm circuit contacts, at the high and low levels of the water. (*Power*, Jan. 23, 1917.)

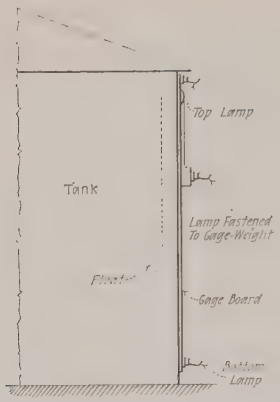


Fig. 281.—A signal, to indicate from a distance the amount of water in a tank. The arrangement consists of three lamps, one placed at the top and another at the bottom of a gage board which is fastened to the tank. The third lamp was fastened to the gage weight, which moved up and down the gage board as the level of the water in the tank varied.

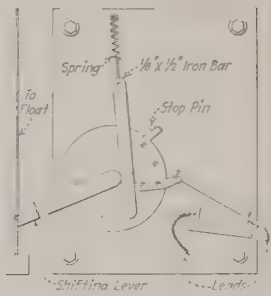


Fig. 282.—An improvised automatic float switch, which can be used to control an electric circuit which operates a pump motor or a warning signal. (*Power*, Mar. 27, 1923.)

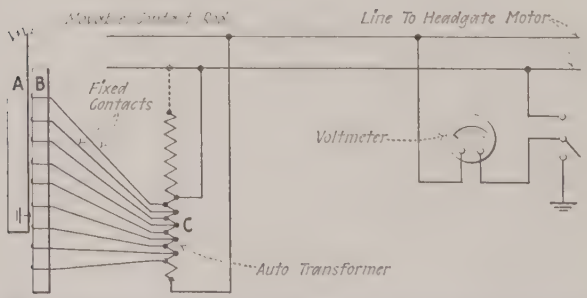


Fig. 283.—Method of distantly indicating a hydro-electric-plant head-gate position by a voltmeter. The rod *A* carries a grounded contact piece, which moves with the gate or at a proportional rate. An auto-transformer, *C*, is connected to the line which supplies the current to the motor on the gate-operating mechanism. This auto transformer is provided with as many taps as are needed, which taps are connected to stationary contacts *B*. A voltmeter is connected as shown and has its scale marked off corresponding to the various positions of the gate. (*Electrical World*, Jan. 6, 1917.)

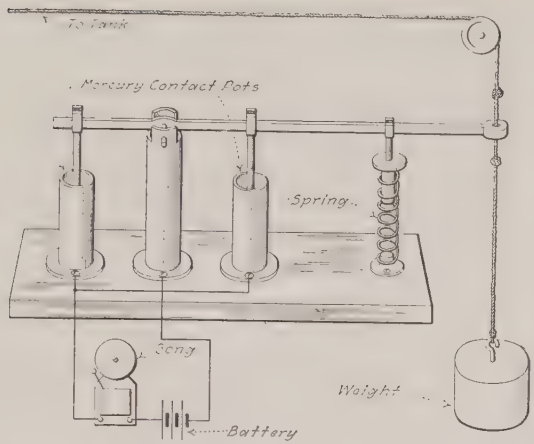


FIG. 284.—A high- and low-water alarm. (S. D. Rodgers in *Power* for May 14, 1918.)

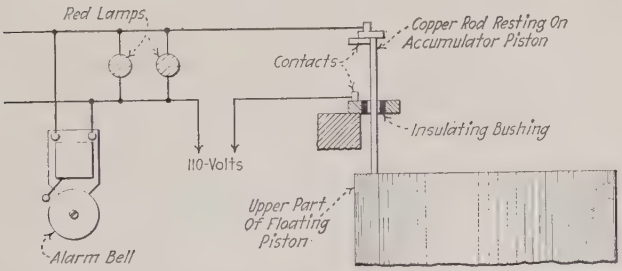


FIG. 285.—An alarm circuit for a step-bearing hydraulic accumulator. Should the pressure of the oil on the step bearings of a turbo-generator fall, the accumulator piston drops closing an alarm circuit which signals the engineer of the trouble. (*Electrical World*, Nov. 8, 1913.)

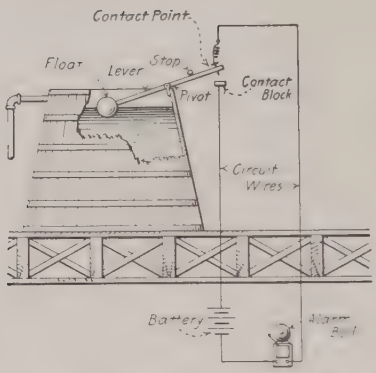


Fig. 286.—Diagram of float-switch alarm signal on a water storage tank. When the water reaches a certain level in the storage tank, the float switch closes an alarm circuit thus sounding a signal.

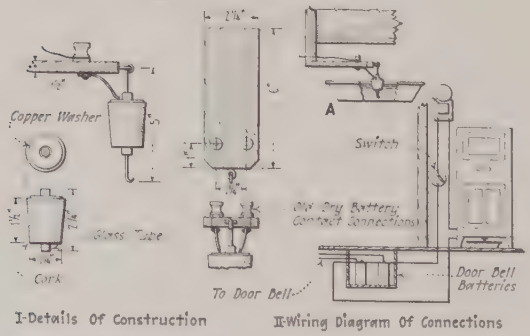


Fig. 287.—Construction of a drip-pan alarm for an ice-box drain. A bell signal is sounded when the water reaches a dangerous level in the drip pan. (*Popular Science Monthly.*)

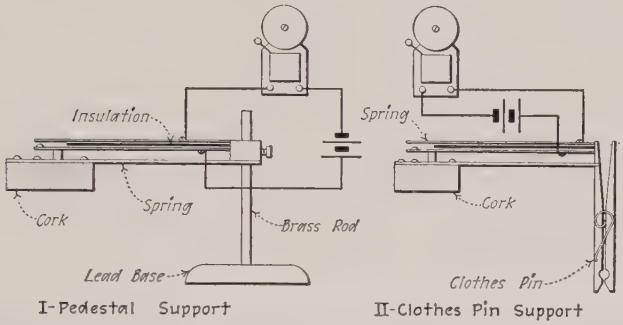


FIG. 288.—Two forms of refrigerator alarm. Both employ the same contact-making scheme. They differ only in the method of supporting the contact-making device to the drip pan. (*Popular Electricity and Modern Mechanics.*)

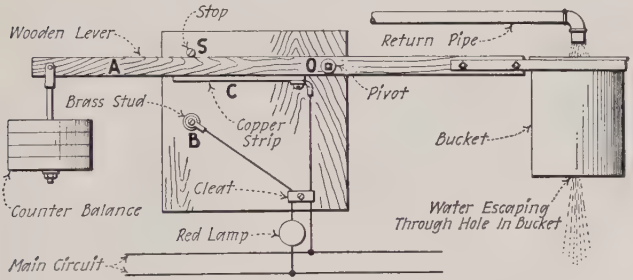


FIG. 289.—Illustration of a device which gives a signal when the circulating water to an internal-combustion engine ceases to flow. A wooden lever *A* is pivoted at its middle point *O*. A galvanized-iron bucket of about 1-gal. capacity, is bolted to one end of the lever. A set of counter weights are hung from its other end. The bucket is hung directly beneath the outlet of the pipe which returns the water to the tower. The lever is balanced so that, as long as water flows into the bucket, the lever takes the position shown in illustration, against stop *S*. A $\frac{3}{8}$-in. hole is provided in the bottom of the bucket to permit the water to escape. When the water stops flowing through the return pipe, the bucket rises causing the lever to make contact between copper strip *C* and brass stud *B* which closes the signal lamp circuit. (*Industrial Engineer*, January, 1923.)

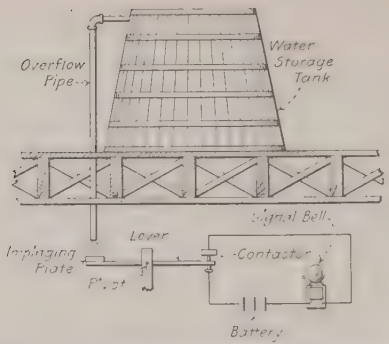


Fig. 290.—Diagram of a water-flow alarm. When water storage tank becomes filled, the flow of water out of the overflow pipe actuates a contact-making lever which closes a bell circuit. This sounds an alarm which notifies the engineer to shut off the valve which feeds the storage tank.

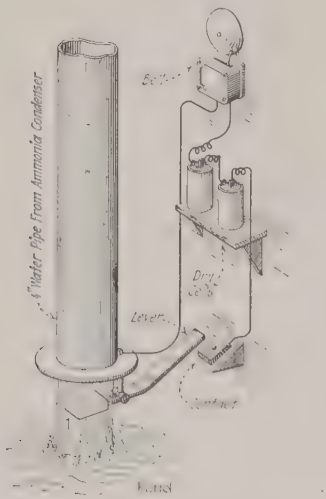


Fig. 291.—Illustration of a water-flow alarm which gives a signal when the water pumps, on the cooling system of an ice plant, stop. (*Power*, January 4, 1921.)

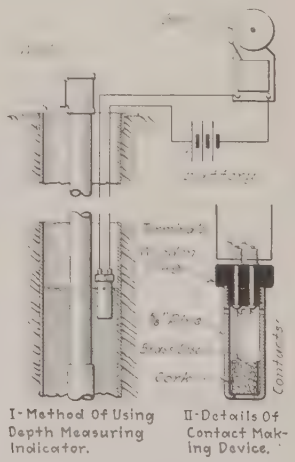


Fig. 292.—Locating the surface of water in a well with a dry cell, bell and specially constructed contact-making device. The contact-making device is lowered into the well. When the level of the water is reached, the cork, to which a metal disc is attached, is raised closing the circuit between the two brass contact bolts and ringing the bell. (*Popular Mechanics.*)

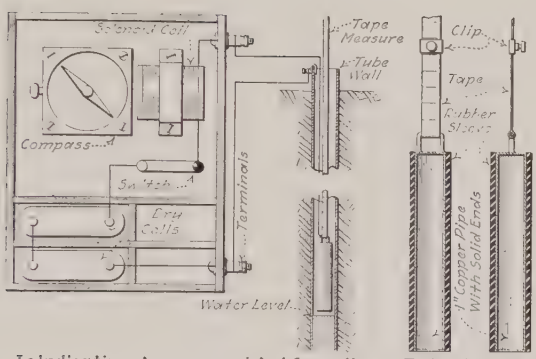


Fig. 293.—A pocket electrical device for measuring water depth in wells. It consists of a small pocket compass, several dry cells, flash-light batteries will do, and a solenoid of fine insulated copper wire. One terminal from the battery is connected by insulated wire and a clip to the pipe in which the depth of the water is to be ascertained. The other is connected through the solenoid winding to a suitable contact plate which can be lowered into the pipe. The contact plate is suspended by an insulated wire and a measuring tape. On lowering the contact plate, which is so insulated that contact is not made with the side of the pipe, a current flows through the solenoid at the instant the water is reached, producing a vigorous *kick* of the needle of the compass. (*Engineering News-Record*, Sept., 1923.)

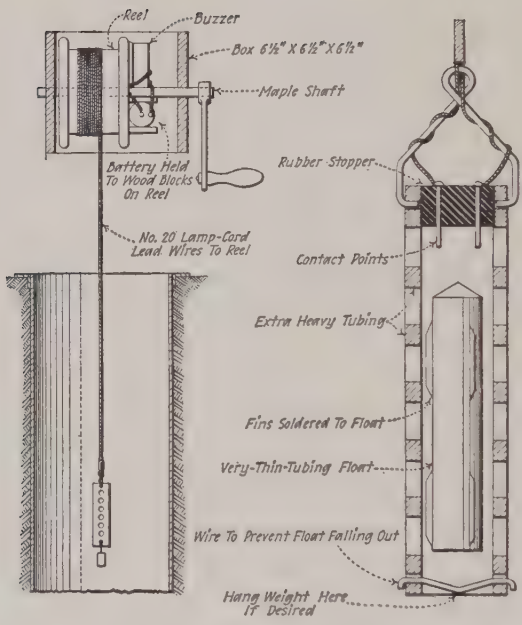


Fig. 294.—Illustrating another well-sounding device. (*Engineering-News*, March 4, 1915.)

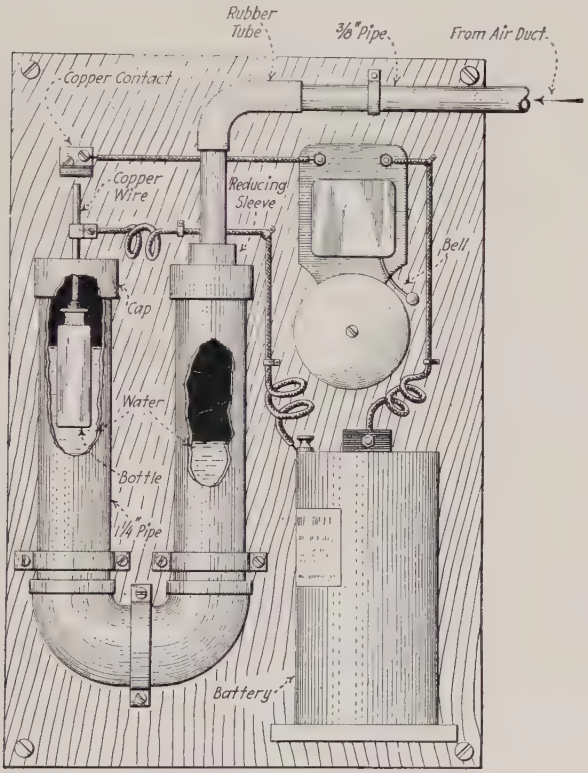


FIG. 295.—Alarm wired to a fan engine to sound a signal when the engine overspeeds.

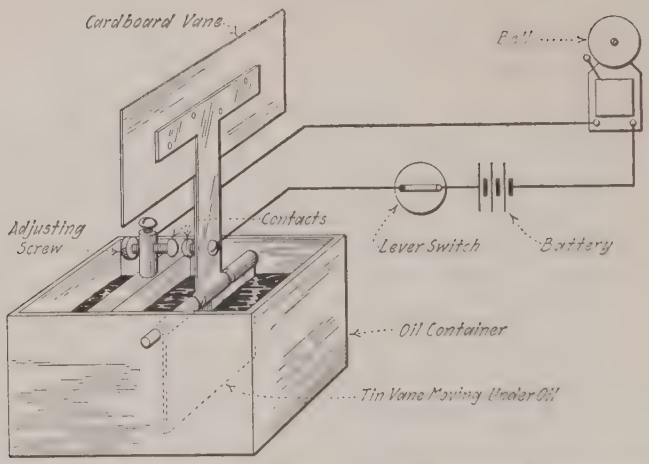


Fig. 296.—An automatic draft alarm. An alarm rings if a wind comes up during the night. Little puffs of air do not affect it, but a steady draft does.

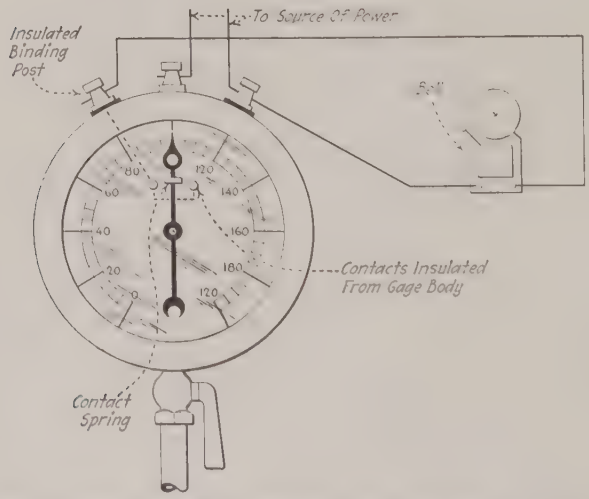


Fig. 297.—Wiring diagram of an alarm signal attached to a steam gage. A high- and a low-pressure contact wire mounted on the gage, with a spring contact fastened to the gage pointer. The pop valve is set so that the signal will sound before the valve pops, giving the fireman warning to prevent the steam losses which accompany the popping of the valve. (*Power*, Feb. 14, 1922.)

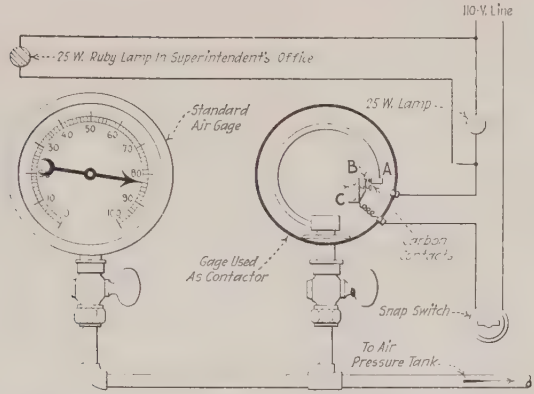


FIG. 298.—A discarded air gage remodeled as a low-pressure indicator. As the spiral (Bordon) tube of the remodeled gage moves inward with a decrease in pressure, a carbon block *A* on one end of the tube contacts with another block *B* on a brass finger which is mounted on a fiber block, *C*, completing the circuit through a visual signal circuit. (*Industrial Engineer*, May, 1925.)

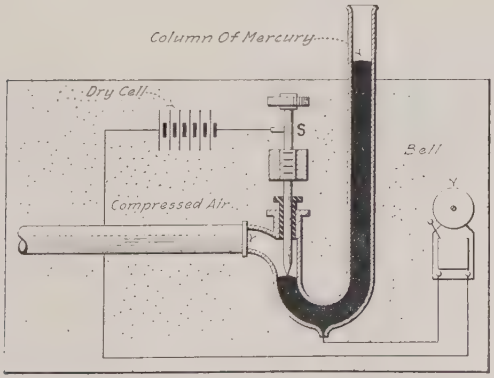


FIG. 299.—Compressed-air alarm employing a mercury column. The circuit is closed between the mercury and an adjustable contact screw *S*. The height of the column of mercury necessary for a given pressure will be about 2 in. for each pound per square inch pressure. (*Power Plant Engineering*, Feb. 1, 1920.)

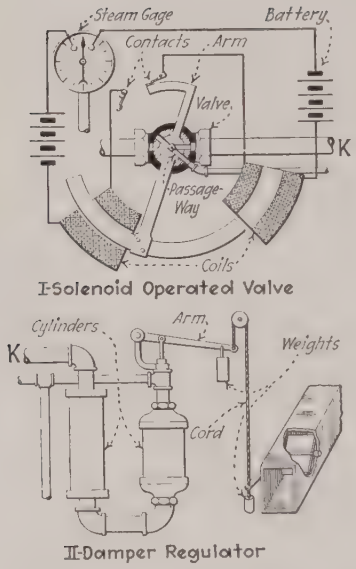


Fig. 300.—An electric damper regulator. Two contacts on the steam gage are connected to a solenoid circuit which regulates the draft in the boilers. (*Practical Electrics*, Sept., 1923.)

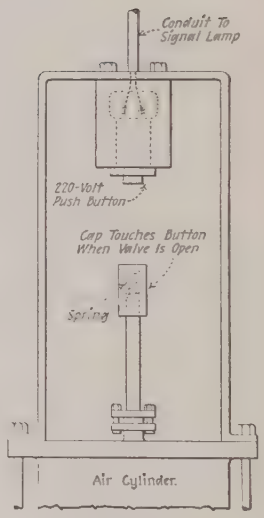


Fig. 301.—A lamp indicator which shows which air-operated valve on a tank opened. The opening of the valve actuates a push button which completes the circuit through a signal lamp.

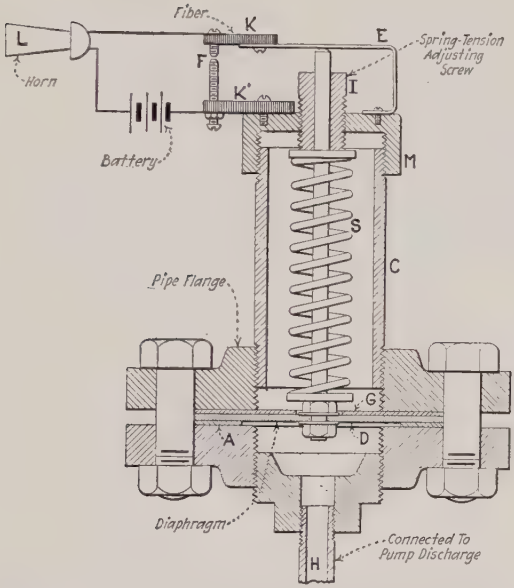


FIG. 302.—A low-pressure alarm. A diaphragm, *D*, is clamped between plate *G* and washer *A* in a 1½-in. flange, the lower opening in the flange being connected to the pump discharge at *H*. A 1½-in. nipple *C* is screwed into the upper opening of the flange, and capped, by a cap, *M*. Into the cap is screwed an adjusting nut, *I*, by which the tension on the spring, *S*, can be varied. A brass spring *E* and a fiber piece *K'* is secured to the cap. Screw contacts, *F*, are screwed into the fiber blocks *K* and *K'*. When the pump stops on the pressure drops, the spring forces the diaphragm *D* down, causing contacts *F* to close and sounding the horn *L*. (*Power Plant Engineering*, June 1, 1921.)

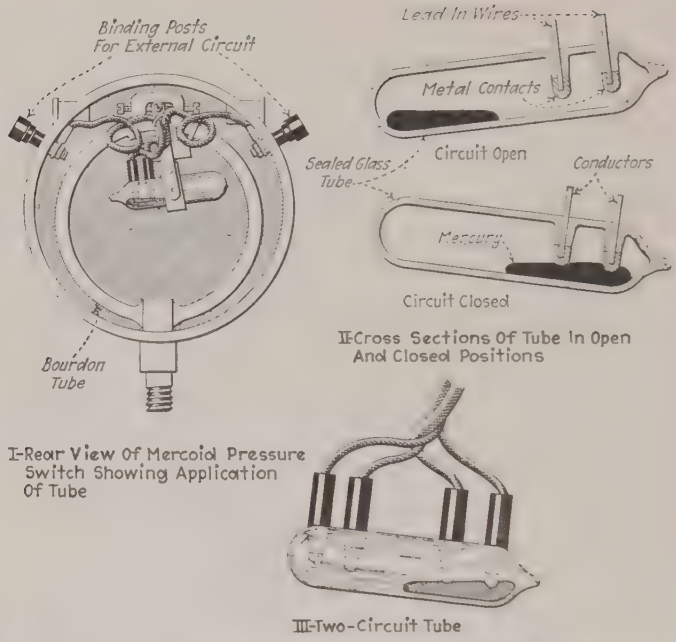


Fig. 303.—Mercury electrical switch for installation where there are explosive gases. The pressure switch shown in *I* consists of a gravity-operated mercury switch actuated by a Bourdon tube, arranged to open or close an electrical circuit at predetermined pressures. The device consists of a glass tube into which are sealed either two or four contacts, depending upon whether it is a one-circuit or two-circuit tube. A quantity of mercury is also sealed into the tube which constitutes the conducting medium for the current between the contacts. By tilting the tube the mercury flows from one end of the tube to the other thus opening or closing the circuit as the case may be. This device, which is for use in chemical plants and other places where there are explosive gases and in which open electrical contacts would be dangerous, is manufactured by the Federal Gauge Co., and the Marshaltown Manufacturing Co. (*Power Plant Engineering*, June 1, 1922.)

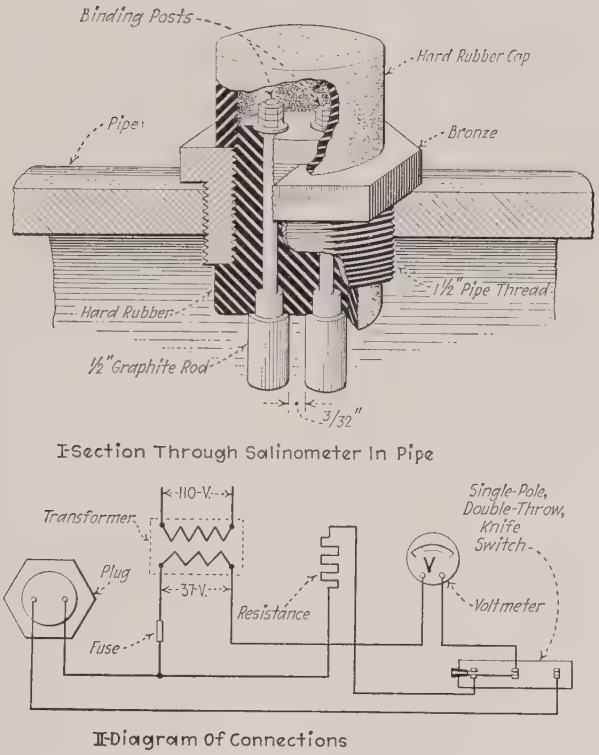


FIG. 304.—An electrically-operated salinometer; illustrating a section through the salinometer mounted in a pipe and a diagram of the electrical connections. (*Power*, July 29, 1919.)

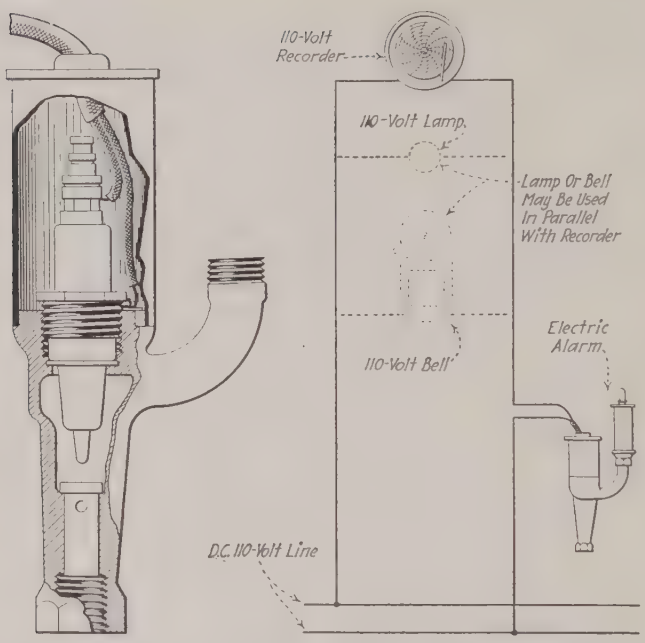


Fig. 305.—Illustrating the Reliance Electric Alarm. This device can be used in connection with, or in place of the whistle on any safety water column to signal when the water level is too high or too low by means of a bell, light or chart. Connections are shown in *II*. (Reliance Gauge Column Co., Cleveland, Ohio.)

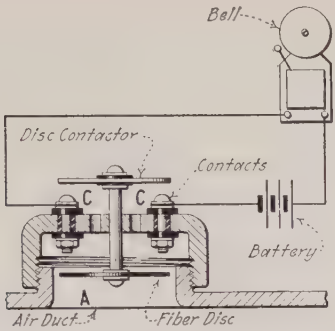


FIG. 306.—An air blast alarm. This device can be used on air blast ducts to indicate when the fan stops. The pipe "*A*" goes down into the air duct and has a cap screwed on the top. Inside of the cap is a disc which is kept blown up against the top of the sleeve as long as the fan is operating. Should the fan stop, the air flow would stop, causing the disc to fall upon the contacts (*C*), closing a bell circuit.

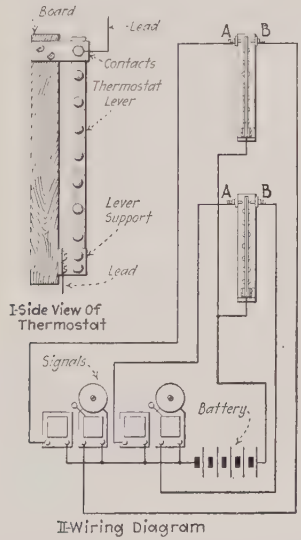


FIG. 307.—A simple home-made thermostat signal. This system was employed to signal the engineer as the temperature varied so that he could maintain the proper temperature in the drying rooms of a certain factory. The thermostat was made from a piece of steel $\frac{1}{16}$ in. thick, rivoted to a piece of brass of the same thickness. The pieces were $\frac{1}{4}$ in. wide and 6 in. long. Contacts *A* and *B* were provided and the riveted thermostatic strips suitably mounted to make contact with *A* and *B* at the desired temperatures. (*National Engineer*, Sept., 1920.)

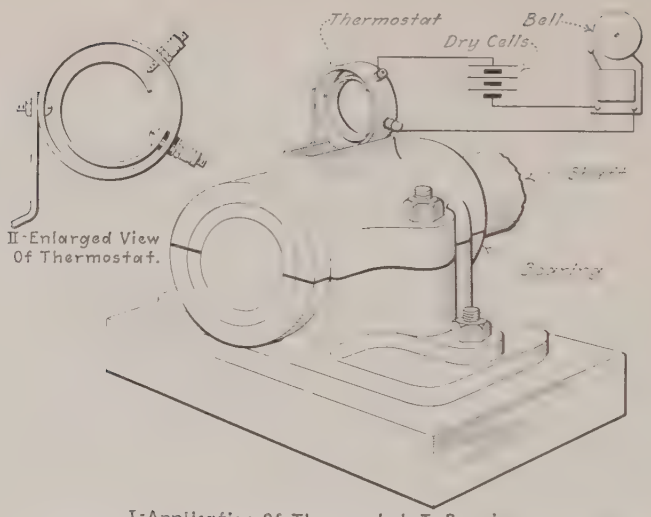


FIG. 308.—A thermostat bearing alarm. (*Power*, Jan. 31. 1922.)

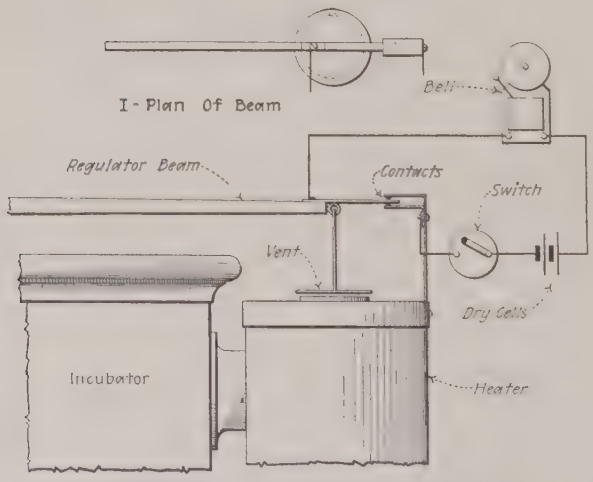


FIG. 309.—An electric incubator alarm which gives an alarm when the temperature is above or below the correct value. Its operation is self explanatory.

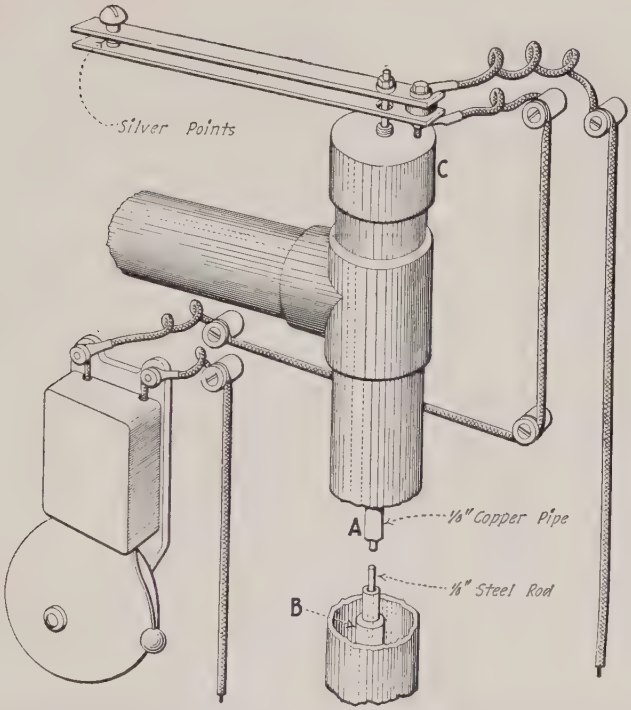


Fig. 310.—A high-temperature alarm for giving a signal when the temperature of the cooling water, from the jacket of an oil engine reaches a predetermined value. It consists of a ⅛-in. copper tube *A* 20 in. long one end of which is screwed into a 1½-in. pipe cap *C*. A ⅛-in. steel rod 23 in. long is screwed into a ⅛-in. pipe cab *B* at the lower end of the copper tube. The free end of the steel rod extends from the copper tube, and is fastened to the contact making springs. The action of the arrangement depends upon the difference in the coefficient of expansion of copper and steel, so that when the copper pipe, lengthens from a rise in the temperature of the water circulating through the large pipe, the steel rod does not lengthen as much and the contacts are brought together, closing an electric circuit and ringing a bell. (*Power*, May 28, 1918.)

DIVISION 11

ELEVATOR SIGNALLING

DIVISION 11

ELEVATOR SIGNALLING

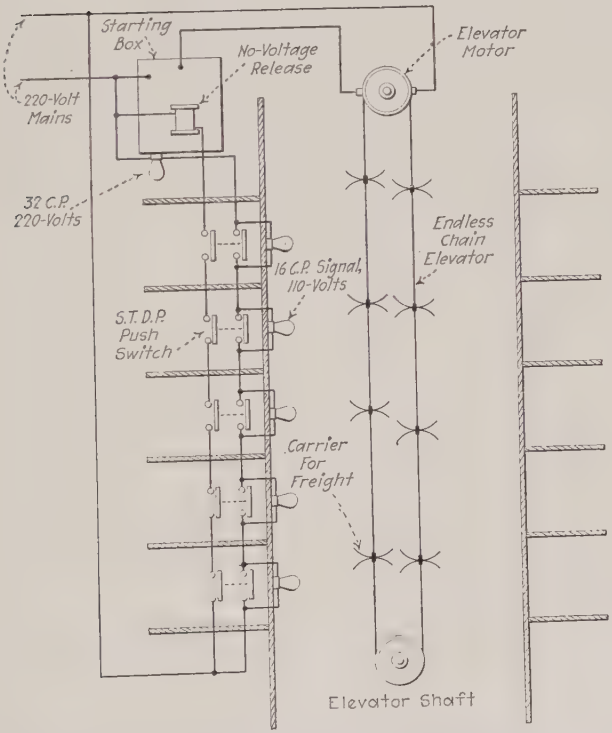


FIG. 311.—Wiring diagram of a switch and signal system for an endless-chain freight conveyor. The conveyor can be stopped at any floor by pressing the push button switch on that floor. When any floor switch is pressed, the conveyor stops and an indicating lamp lights in the conveyor shaft on the floor at which the conveyor was stopped. (*Electrical World*, Oct. 11, 1919.)

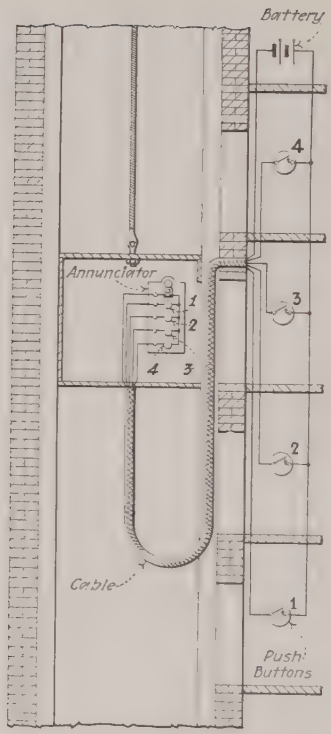


Fig. 312.—Wiring diagram of a simple 4-floor elevator annunciator.

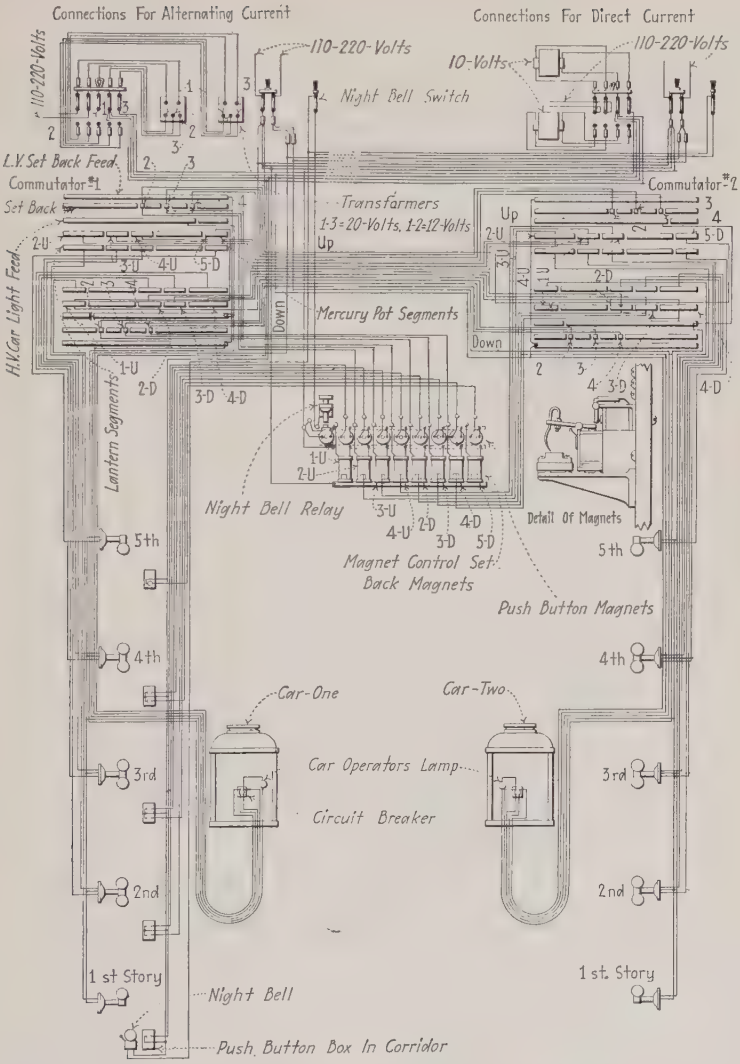


FIG. 313.—Wiring diagram for a complete flashlight signal system for elevators. (ELEVATOR SUPPLIES CO., INC., Hoboken, N. J.)

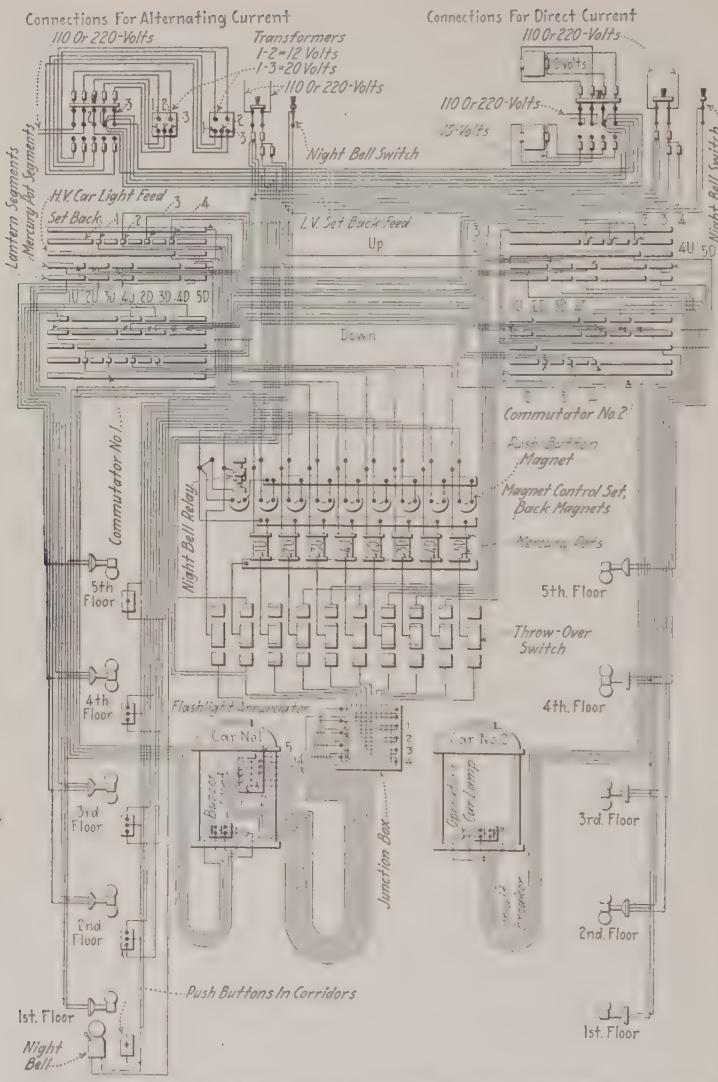


Fig. 314.—Wiring diagram for a complete flashlight signal system for elevator. This system provides a flashlight annunciator in one of the elevator cabs. (Elevator Supplies Co., Inc., Hoboken, N. J.)

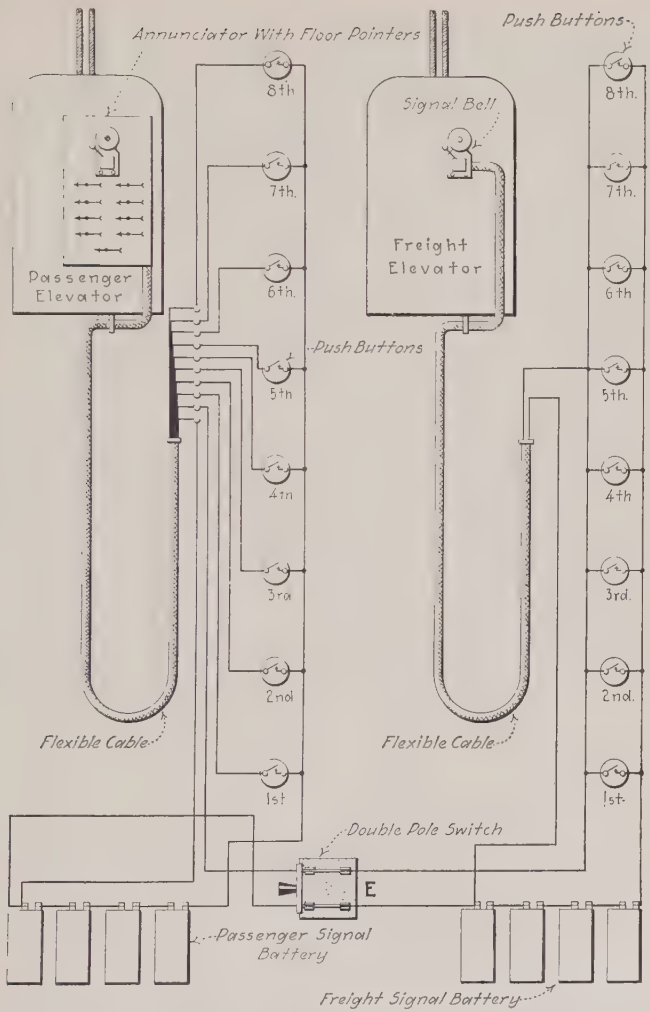
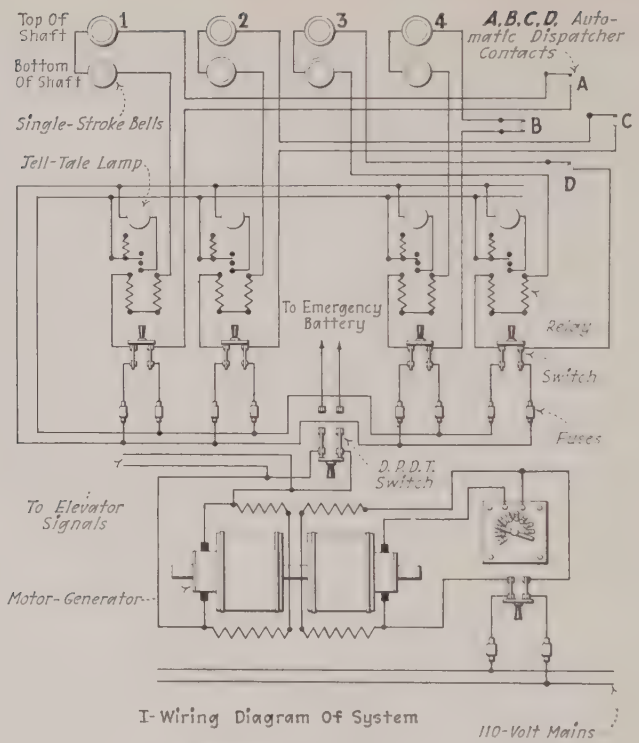


FIG. 315.—Wiring diagram of an elevator signal system which enables one attendant to operate two elevators on Sundays and holidays. The scheme consists in connecting an annunciator drop in the passenger elevator so that it will give a signal and thus notify the operator when the button for the freight elevators is pushed. The freight elevator is equipped with a simple annunciator bell only, while the passenger elevator has a nine-point annunciator, eight points of which correspond to floor signals and the ninth to the freight elevator signal. A double pole switch *E*, connects the ninth annunciator point to the freight elevator signaling system.


Top Of Shaft
1
2
3
4
A.B.C.D. Automatic Dispatcher Contacts
Bottom Of Shaft
A
B
C
Single-Stroke Bells
Tell-Tale Lamp
D
To Emergency Battery
Relay
Switch
Fuses
D.P.D.T. Switch
To Elevator Signals
Motor-Generator
I-Wiring Diagram Of System
110-Volt Mains

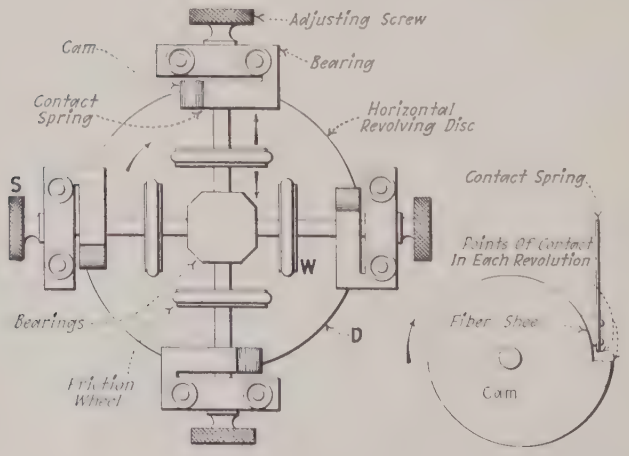

Adjusting Screw
Cam
Bearing
Contact Spring
Horizontal Revolving Disc
S
Contact Spring
Points Of Contact In Each Revolution
W
Bearings
D
Fiber Shoe
Friction Wheel
Cam
II-Plan Of Dispatcher
III-Cam And Spring Contact

Fig 316.

Fig. 316.—An automatic electric elevator dispatcher. The device automatically rings bells located at the top and at the bottom of each elevator shaft. The ringing of the bells can be timed over a range of from 20 to 60 sec. The dispatching device is shown in *II*, which consists essentially of a horizontal revolving disc *D*, operated through reducing gears by a $\frac{1}{6}$ hp. motor at a constant speed. Friction wheels *W* are mounted on suitable shafts, and are driven by contact with the disc *D*. The speeds of these shafts are varied by moving the friction wheels toward or away from the center of the disc by means of an adjusting screw *S*. A contact-making cam and spring *III* operate by means of these shafts. The wiring diagram in *I* illustrates the connection for a system using four groups of signals. A motor generator furnishes energy at 15-volt direct current, a storage battery being provided for emergency use. Tell-tale lamps notify the attendant of the dispatch signals. (Norman G. Meade, *Power*, April 20, 1915.)

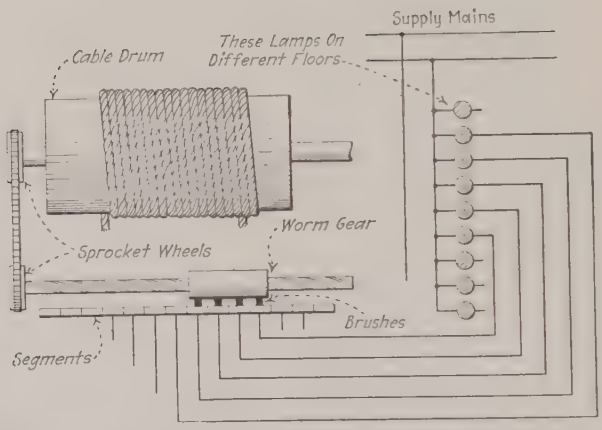


Fig. 317.—Floor signaling connection indicating the approach of an elevator by signal lamps located in halls over the elevator entrances. The contact making device is chain driven from the winding drum.

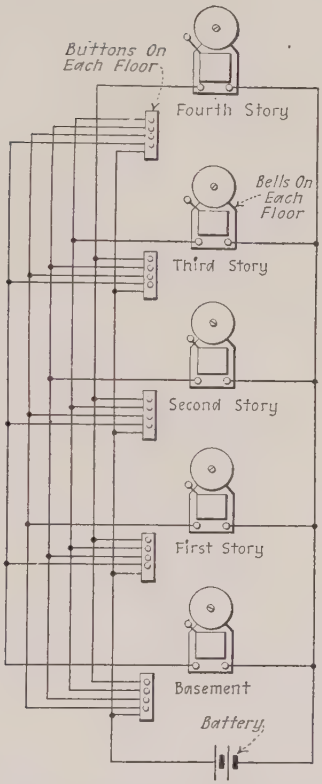


FIG. 318.—Wiring diagram for a dumb-waiter signal system with bank buttons at each floor. When the dumb waiter car is sent from one floor to any other, the button which corresponds to the floor to which the dumb waiter is sent—the receiving floor—is pressed. This notifies, by the ringing of the bell on the receiving floor, that the dumb waiter is there awaiting attention. (ELEVATOR SUPPLIES CO., Hoboken, N. J.)

DIVISION 12

MINE SIGNALS

DIVISION 12

MINE SIGNALS

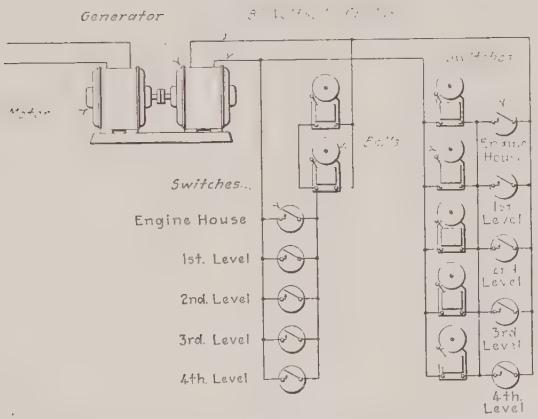


FIG. 319.—Wiring diagram illustrating two types of mine signal circuits. This system operates on 80-volt, 19-cycle energy supplied from a small motor-generator set, the motor of which operates directly from the 110-volt, 60-cycle alternating-current supply lines. Polarized bells are used. (*Electrical World*, Oct. 18, 1919.)

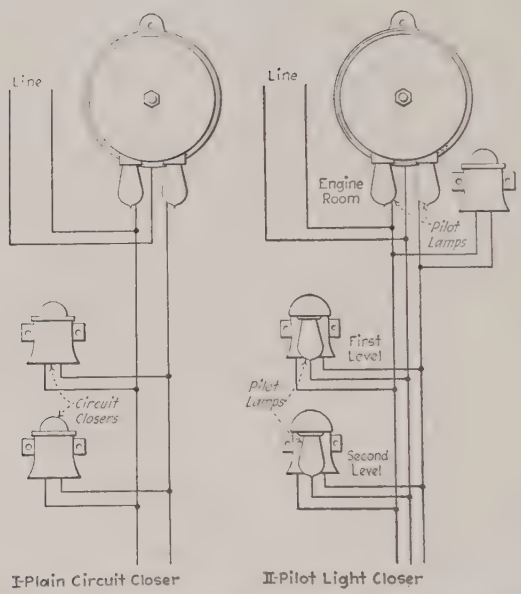


Fig. 320.—Wiring diagram of a plain circuit closer, *I*, and a one-pilot-light closer, *II*, used on mine signaling circuits. The system shown in *I* is recommended for use in tunnels or open work where there is no hoisting. The plan shown in *II* is recommended in mines having several levels. With this arrangement all of the pilot lamps on the closers at the various stations flash when any one circuit closer is pulled. This warns all other stations that a signal has been given and also gives the man sending the signal a visual evidence that the signal is working. (Colorado Mine Signal, Flint Electric and Mfg. Co., Denver, Colo.)

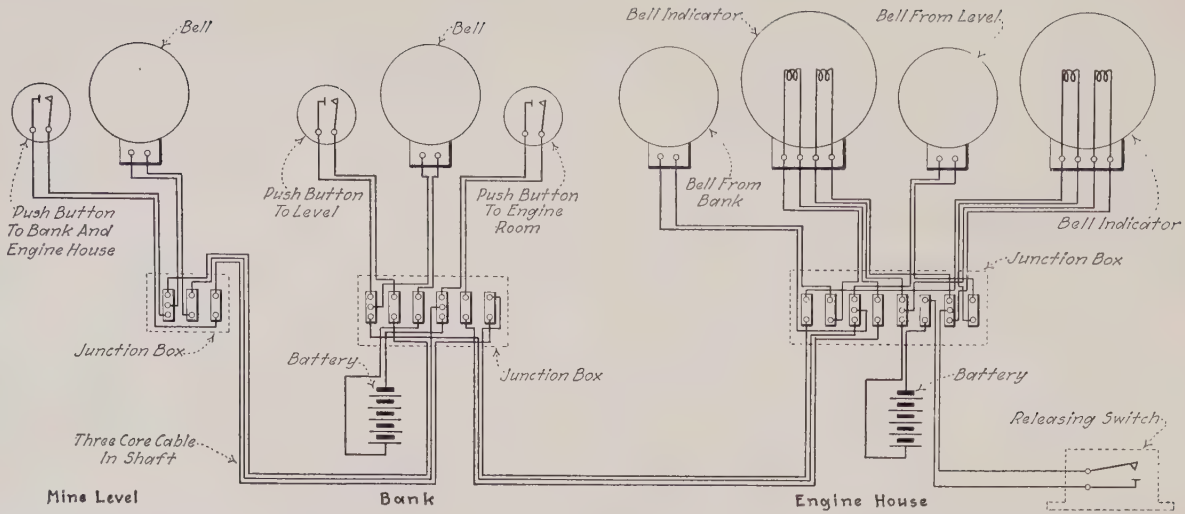


Fig. 321.—Diagram of a bell signal indicator system for a mine shaft which has but one level. Two bells with a dial indicator are provided in the engine house. The indicator indicates the number of strokes made by the bells, thus forming a visual signal. A bell and two push switches are also provided at the bank—at the top of the shaft—and a bell and push switch at the mine level. Various code systems are used for signaling between the mine level bank and engine room. ("Electric Mine Signaling Installations" Lummis Patterson.)

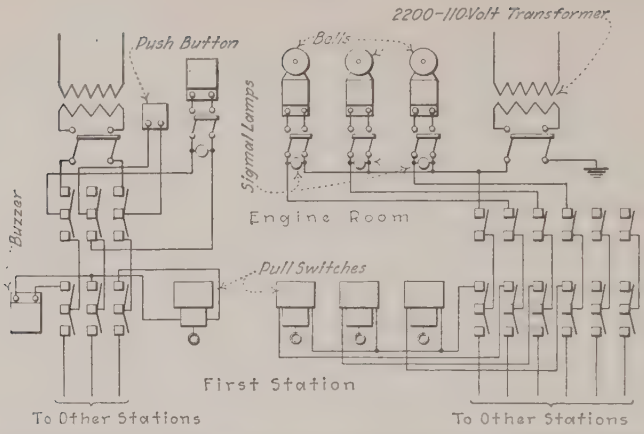


Fig. 322.—Electric mine engine-room signal installation in Butte, Montana mines. (*Mining and Metallurgy*, Feb., 1922.)

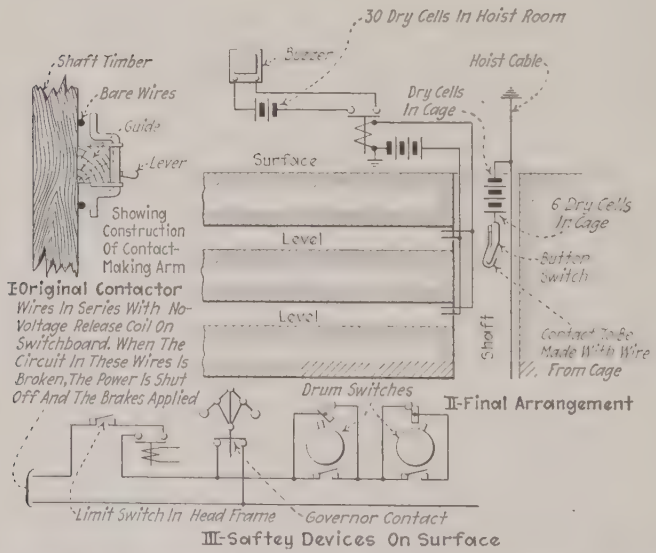


Fig. 323.—Mine signaling system operable from the cage. The device shown provides means for completing the circuit between two wires which extend down the shaft. See also Fig. 328. In *I* is shown the original device, which was installed in the cage, for completing the circuit between the two bare wires which extended down the shaft. In *II* is depicted the present system for signaling, either from the cage or from any one of the various levels.

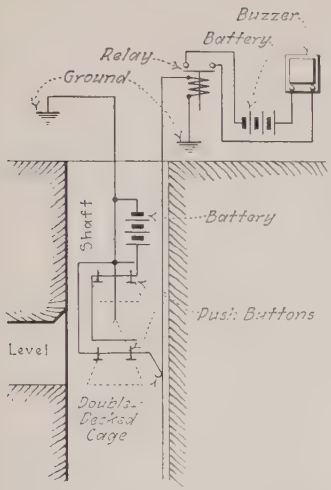


FIG. 324.—Mine signaling system where all signals to the hoisting engineer must be given from the cage. Four push buttons are installed upon the double decked cage. They may be operated by the person on the cage or may be pushed by the cager on the level landing. (*Coal Age*, Oct. 28, 1920.)

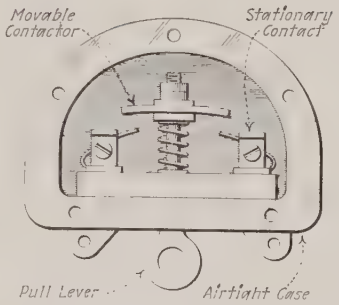


FIG. 325.—A battery-circuit-type mine-signal pull switch manufactured by THE ELECTRIC SERVICE SUPPLIES CO., Philadelphia, Pa.)

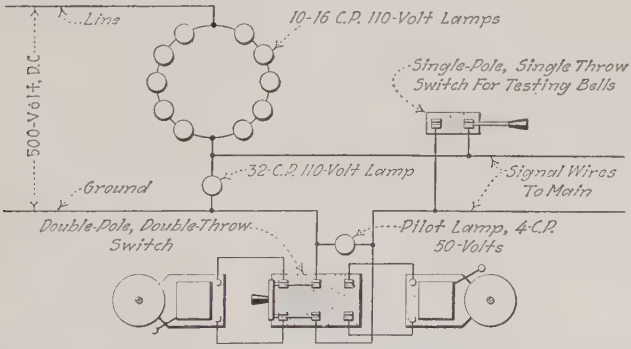


FIG. 326.—A simple electric mine signaling system. In the engine room the current to operate the gongs is supplied by shunting the ground light of a series of ten 16-cp., 110-volt lamps, as shown in diagram. Signals from the mine are sent by short-circuiting the wires in the slope by means of copper spanner of ample width so that the trip runner can close the circuit, without having to get off the trip or grasp the signal wires in his hand. (*Coal Age*, Feb. 8, 1913.)

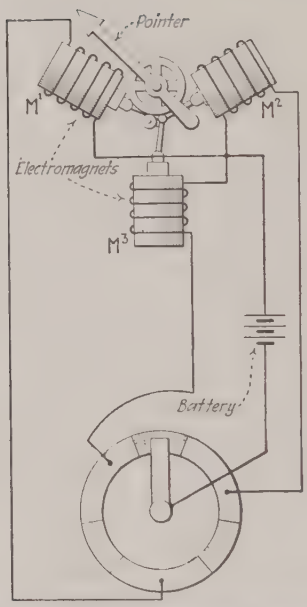


Fig. 327.—Diagram illustrating the operation of the combined transmitter and receiver. The recorder is furnished with three electro-magnets M^1, M^2 and M^3, the iron cores of which slide in and out when their respective windings are energized. The electro-magnets are arranged in a circle around a center crank, to which the movable cores are coupled. The angular displacement of each electric-magnet with respect to the others is 120 degrees. To rotate the center crank once in a clockwise direction a current impulse must be sent through M^3 another through M^1 and a third through M^2. The crank is geared by a small pinion to a large cogwheel, R, to which a pointer is attached. The pointer can be moved to any desired number on the dial in front of which it is placed. ("Electric Mine Signalling," Lummis Patterson.)

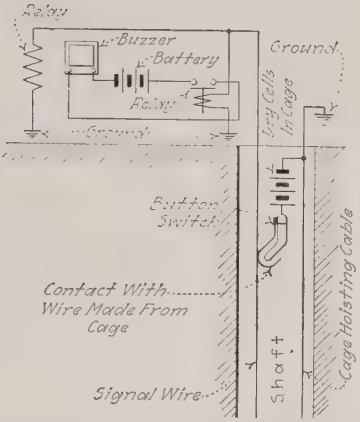


FIG. 328.—Mine-signal-device diagram for both signal and cage-control circuit. See also Fig. 324. Means for signaling from the levels are omitted from the illustration. It will be noted that the cable and the hoist itself form part of the signaling and control circuit.

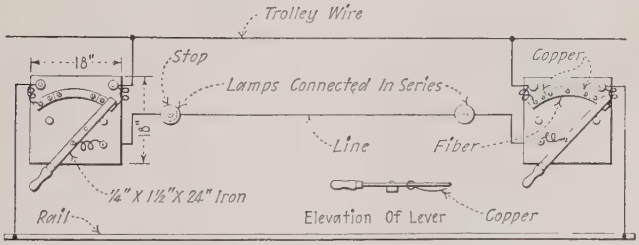


FIG. 329.—Diagram of a practical manually-operated block-signal system for a mine-locomotive haulage system. When an incoming locomotive passes the first switchboard, the motorman throws the lever and thus opens the circuit, thereby blocking the road. On reaching the next switchboard, he throws its lever, which closes the circuit, causing the two 125-volt lamps to burn and showing the road is clear for the following locomotives. The lights should be placed close to a siding, so that the motorman can clear the road for other locomotives. The lights burn when the road is clear and are out when the road is blocked.

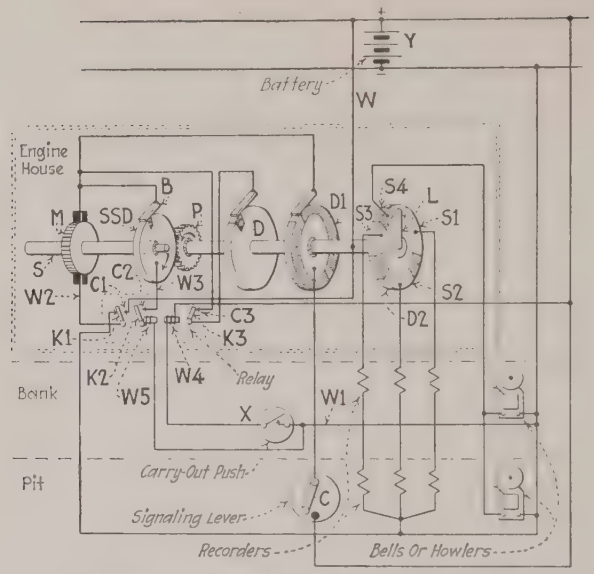


Fig. 330.—An automatic mine signaling switching device, the function of which is to store up the signal given at any point and to pass the signal on to the engineman when the banksman depresses the carry-out switch *X*. The illustration is merely schematic, only the parts necessary for a description of the operation of the device are shown. The apparatus inside the double dotted lines represents the automatic switch. A motor *M* is coupled to a shaft *S*, on which are fixed a pinion, *P*, and two discs, *D* and *D1*. The pinion, *P*, drives the signal storing disc, *SSD*. A brush, *B*, bears on a piece of insulating material fixed on the edge of the disc, *SSD*. Disc *D* has also a small segment of insulating material on which a brush bears until the disc is moved and its metallic part brought in contact with the brush. Disc *D1* has a rim of insulating material except at one point where the brush bears on a segment forming a part of the solid metal. Disc *D2* is stationary, so that when the motor turns the shaft the brush, *L*, is brought into contact with the segments, *S1*, *S2*, *S3* and *S4*, in the order named. The order in which contact is made with these segments is reversed when the direction of rotation of the motor is reversed. The slightest turn of the pinion, *P*, will cause the metallic part of the disc, *SSD*, to be brought into contact with the brush, *B*. Assuming that the onsetter in the mine wishes to give a signal corresponding to "3" on the recorder, he brings his signaling lever in contact with *C* three times. Each time the lever is brought into contact with *C* the following circuit is closed, and the following functions are performed by the automatic switch:

The circuit closed may be traced from the positive (+) pole of the battery, *Y*, through the signaling lever, disc *D1*, motor armature, *K1* of the relay and back to the negative (−) pole of the battery. The motor instantly turns the shaft and breaks the contact at disc *D1*, but at the same time causes contact to be made at *D*, so that the current is kept flowing from positive of the battery through wire *W*, shaft, disc *D*, *K3* of relay and through the motor to the negative pole of the battery. The shaft therefore must make a complete revolution before the contact with the brush *D* is broken again by the segment

1. This one revolution of the shaft will have caused two distinct functions to have been performed:

(1) A current impulse will have been sent through the medium of brush, *1*, through each of the three coils of each recorder and through the bells or horns. The pointers of the recorders will, therefore, have moved to the next point on the dial, and the bells or horns will have sounded once. (2) The pinion, *P*, will have turned the disc, *SSD*, around a certain distance. The signal storing disc, *SSD*, is so geared as to make only one revolution when the shaft, *S*, has turned the maximum number of times. The slightest turn of the shaft will bring brush *B*, into contact with the metallic part of the disc *SSD*. The pinion, *P*, having been turned around three steps through the signaling lever being brought into contact with *C* three times, the *carry-out* push button is now depressed by the banksman. A current will thus flow which may be traced from the negative pole of the battery, through *W1*, carry-out push, winding *W4* of relay, to the positive pole, of the battery *Y*. The armature springs, *K1*, *K2* and *K3* then come into contact with *C1*, *C2* and *C3*, and current flows through winding *W3* to the motor. As the current is now sent through the motor in the opposite direction to that which it flowed, when the signaling lever was operated, the motor will turn back the shaft, *S*, until the insulating segment on *SSD* comes under brush *B* again. The shaft, *S*, is turned backward exactly the same number of times as it was previously turned forward, and the pointers on the recorders are also moved back to the starting point. When the current ceases flowing through the motor by virtue of disc *SSD*, the relay releases and the springs *K1*, *K2* and *K3* go back into their normal positions.

As it was assumed at the outset that signal No. 3 was to be given, the shaft, *S*, was caused to make three complete turns before the carry-out push was depressed. When the carry-out switch was depressed the shaft, *S*, was turned back three complete turns by virtue of the signal storing disc *SSD*. ("Electric Mine Signaling," LUMMIS PATTERSON.)

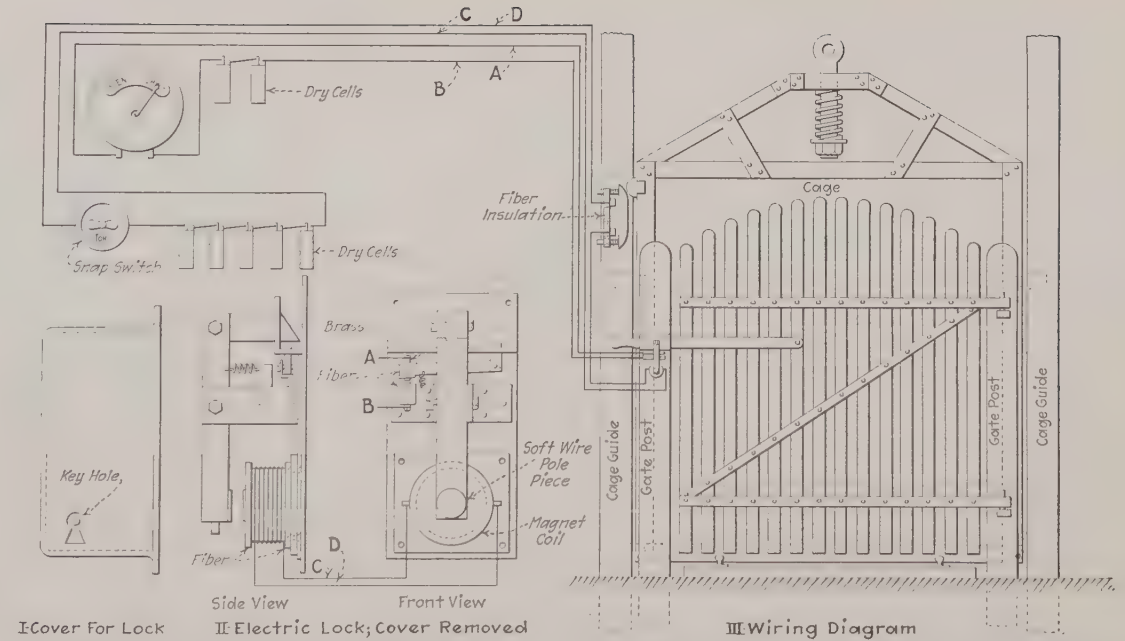


FIG. 331.—Illustration of an automatic safety lock for a shaft gate, together with a dial indicator showing whether the shaft gate is open or closed. An electro-magnet actuates the locking mechanism. An indicator, which is located in the engine room, shows at all times through suitable electrical connections, the movement of the latch bar. When the latch bar is disengaged from the locking mechanism, the dial stands at the open position while when the gate is closed and when the latch bar is dropped into place, the dial indicates that the gate is closed. (*Coal Age*, May 29, 1915.)

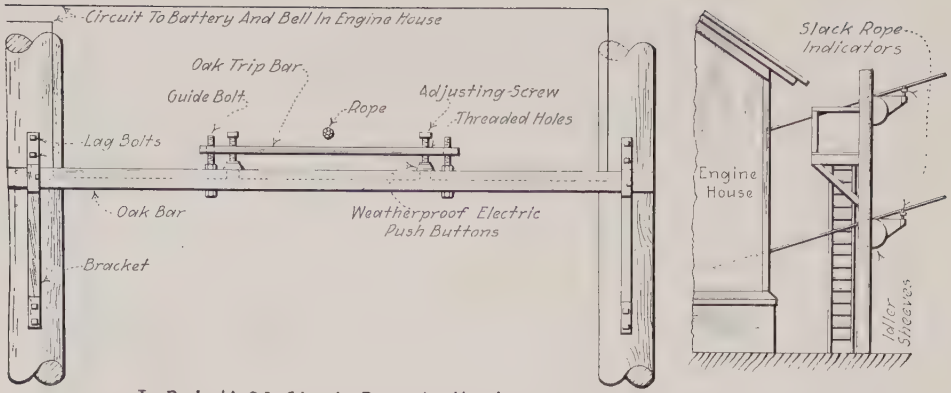


Fig. 332.—A device for indicating to the hoisting engineer any slackness in the hoisting rope, due to the skip getting stuck in the shaft or to any other causes. (*Engineering and Mining Journal*, January 1, 1916.)

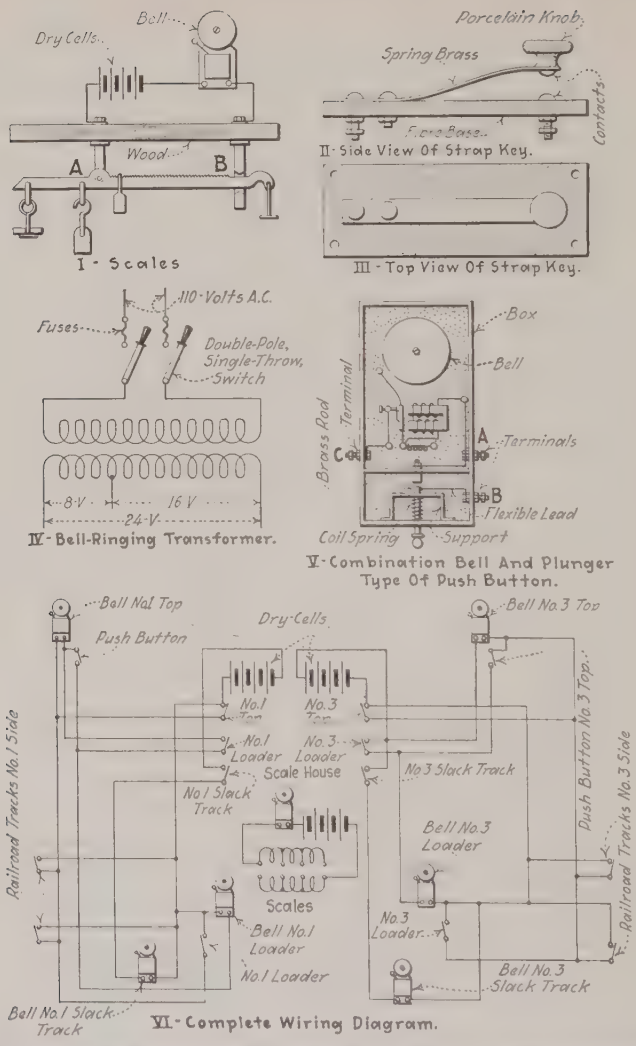


Fig. 333.—Diagram of a signal system which enables intercommunication between various locations on the tipple. The scale signal is semiautomatic in that, when a car has received a certain load, a warning bell is sounded. (*Coal Age*, June 8, 1918.)

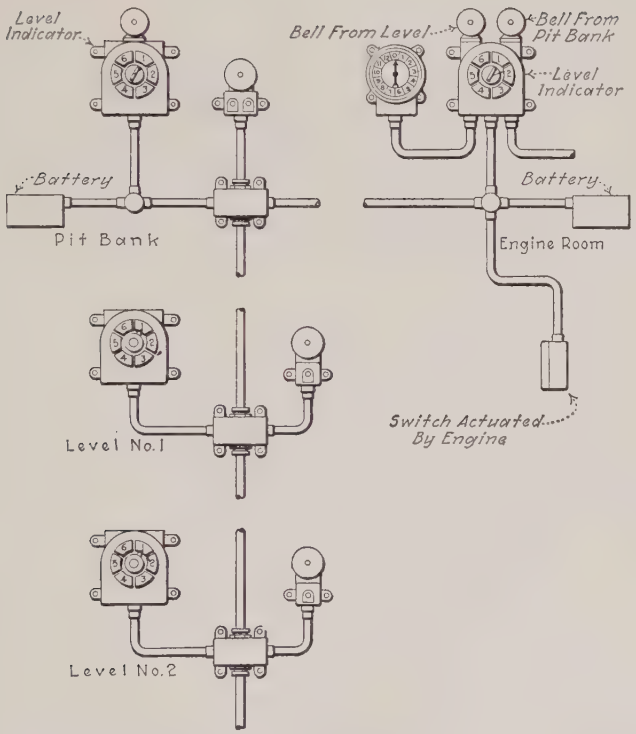


FIG. 334.—A bell signal system with indicator, for mines having two or more levels. Level indicators are provided at each level. These level indicators are controlled by the banksman who indicates to the onsetters to which level the cage is going and also to the engineman to which level to work the cage. Means are also provided with this system whereby only the level to which the cage is working can send orders to the engineman. This eliminates the possibility of an onsetter of another level sending a signal to the engine house and causing the indicator to register a wrong number of bell strokes. However, each onsetter can communicate with the banksman to indicate when he requires the cage to stop at his level. ("Electric Mine Signaling," LUMMIS PATTERSON.)

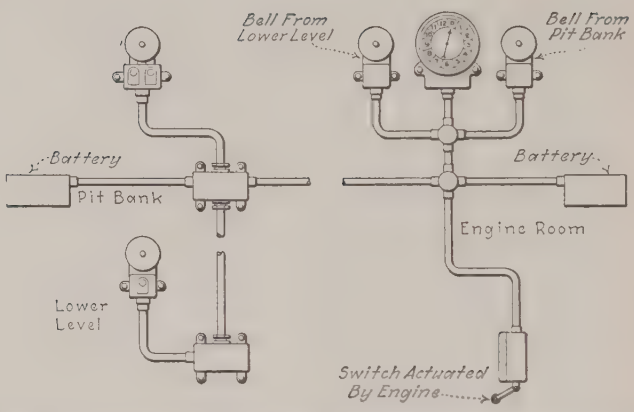


Fig. 335.—The arrangement in which the various appliances shown in Fig. 321 are installed. ("Electric Mine and Signaling," Lummis Patterson.)

DIVISION 13

RAILROAD SIGNALING

DIVISION 13

RAILROAD SIGNALING

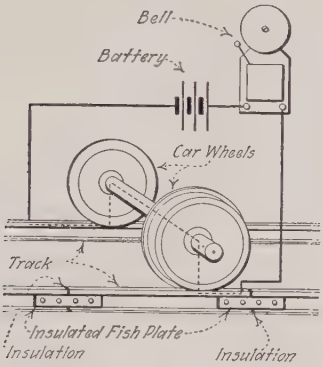


FIG. 336.—Illustration showing the principle of the operation of a railway track signal, using an insulated section of rail to operate it.

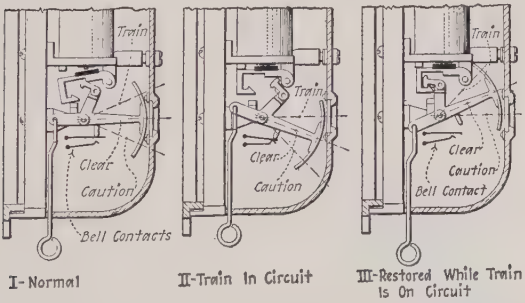


FIG. 337.—Illustrating the various positions of a Universal train annunciator. Manufactured by the Chicago Railway Signal and Supply Co. *Position I* shows the annunciator in its normal position, the card displaying "Clear" with the local bell contacts open. In *II* the annunciator indicates a train in the circuit, the local bell contacts closed. The annunciator restored while the train is on the circuit and the local bell contacts open is shown in *III*. (CHICAGO RAILWAY SIGNAL AND SUPPLY CO., Section A.)

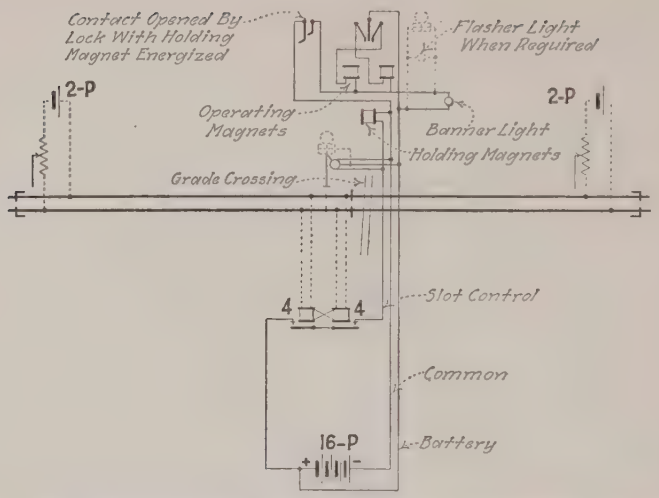


Fig. 338.—Wiring diagram of a single-track, direct-current automatic flagman with direct-current track circuit. (Union Switch and Signal Co.)

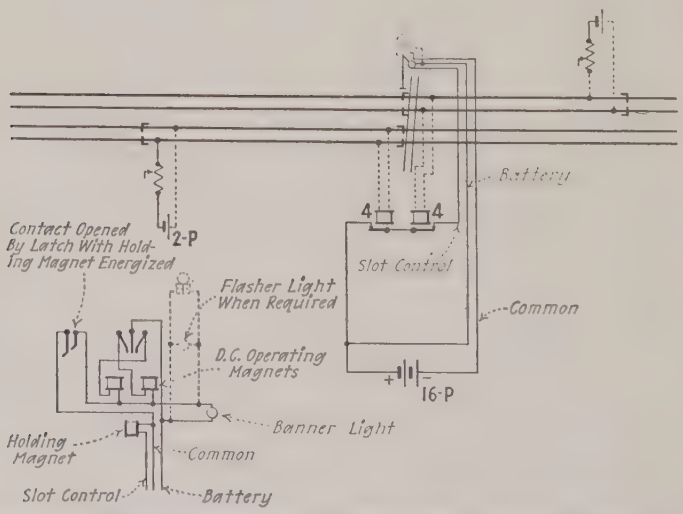


Fig. 339.—Wiring diagram for a direct-current automatic flagman for a double track road with direct-current circuit. (Union Switch and Signal Co.)

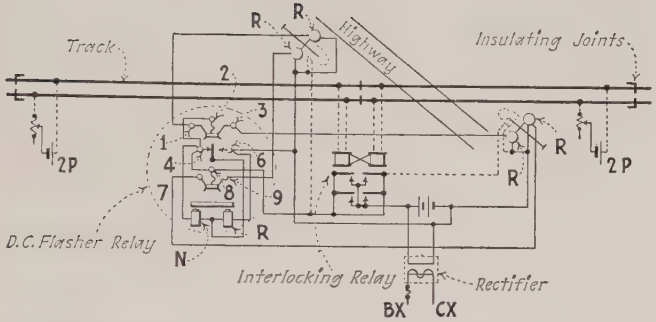


FIG. 340.—Wiring diagram for a single-track, light signal circuit, for a highway crossing. (UNION SWITCH AND SIGNAL CO.)

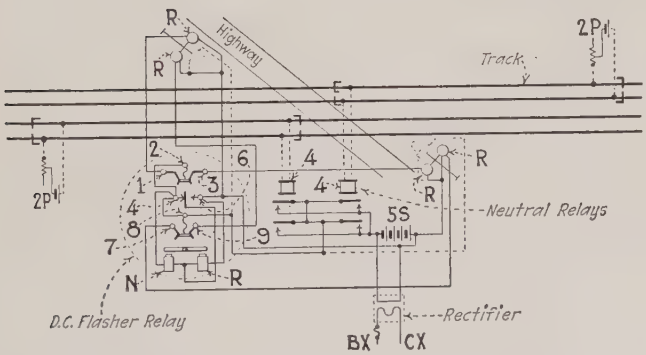
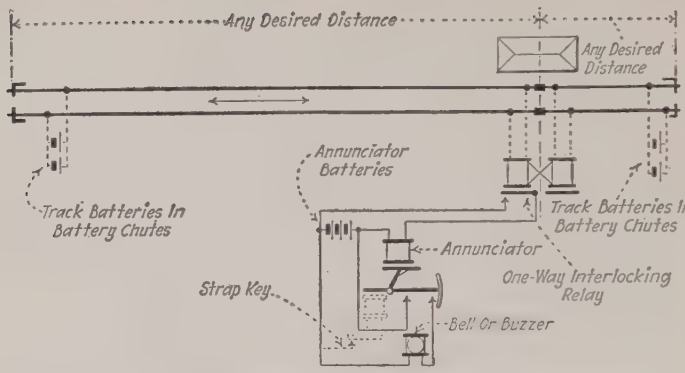
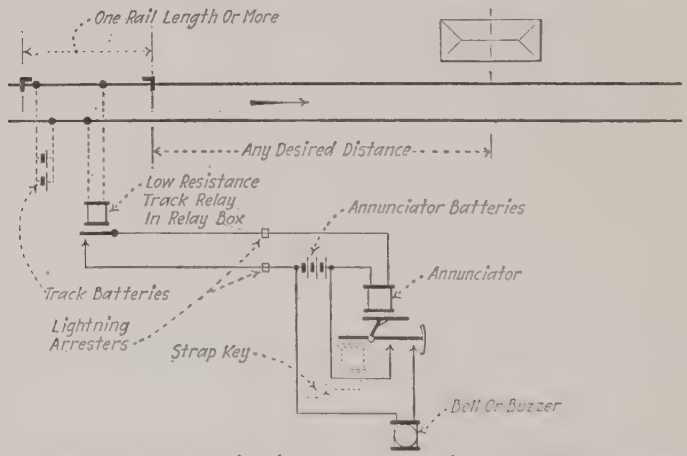


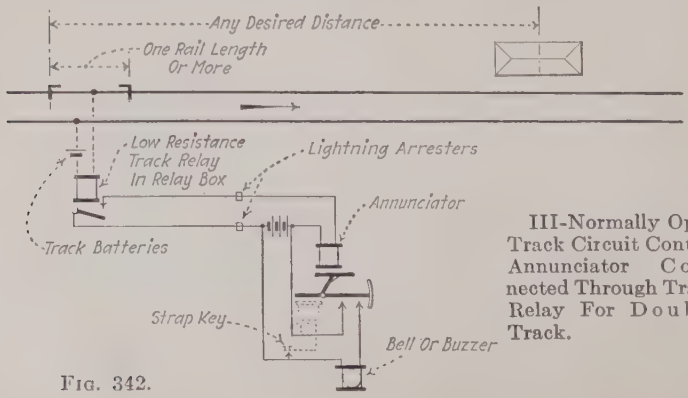
FIG. 341.—Wiring diagram for a double-track, light signal circuit, for a highway crossing. (UNION SWITCH AND SIGNAL CO.)



I-Closed Track Annunciator Operated By Trains In One Direction Only



II-Normally Open Track Circuit Control Annunciator Connected Through Track Relay For Double Track



III-Normally Open Track Circuit Control Annunciator Connected Through Track Relay For Double Track.

Fig. 342.

Fig. 342.—Wiring diagrams of railway annunciator circuits Nos. 5104, 5103 and 5102 respectively. (Chicago Railway Signal and Supply Company, Section A.)

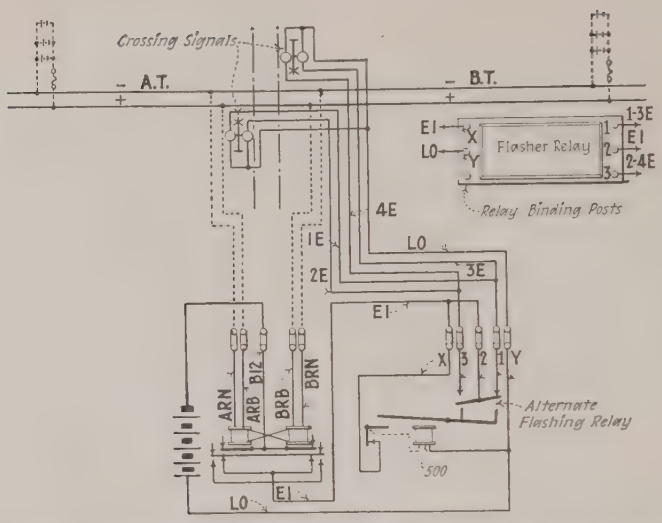


Fig. 343.—Typical wiring plan of a Model *A* Adler alternate flashing relay used on railway highway crossing signaling. This system operates on 10 to 12 volts direct current.

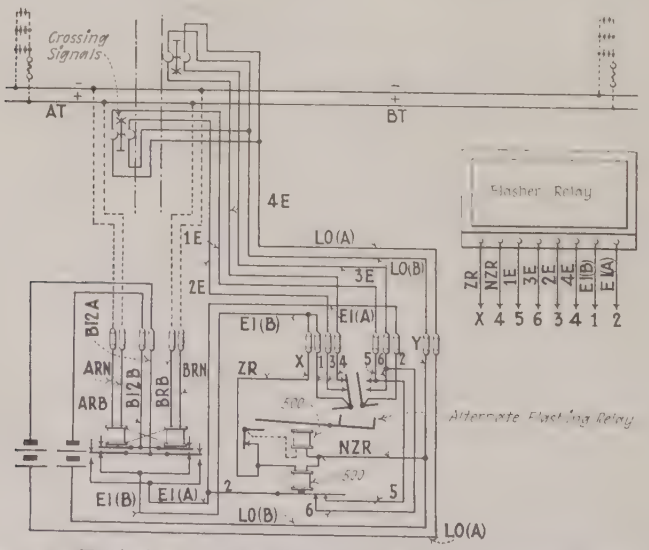
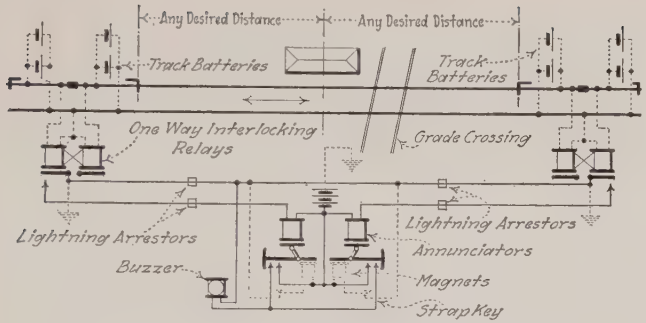
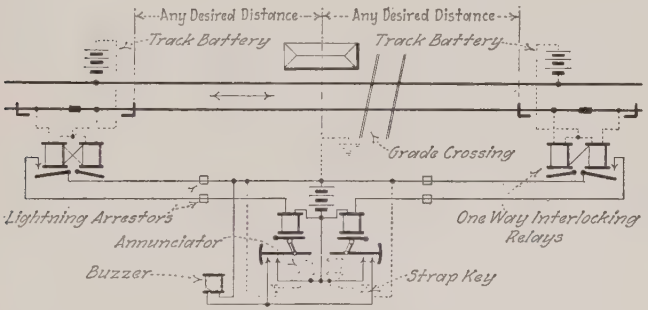


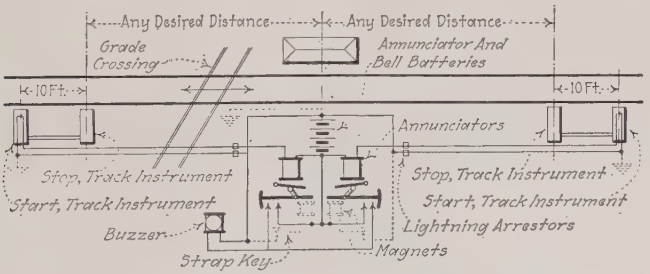
Fig. 344.—Typical control circuits for highway crossing signals using Adler alternate flashing relay Model *B*. This system operates on 10 to 12 volts direct current.



I-Single Track-Closed Circuit Control. Interlocking Relays. Independently Operated Annunciators.

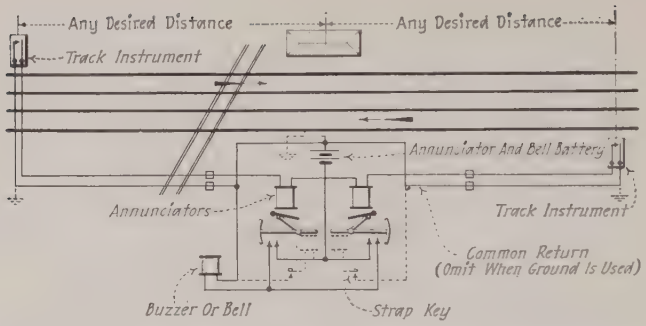


II-Single Track-Open Track Circuit Control. Interlocking Relays. Independently Operated Annunciators.

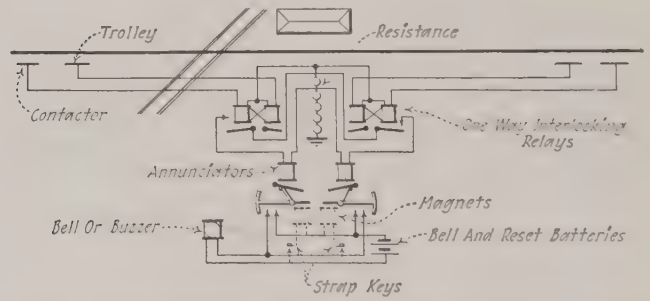


III-Single Track With Track Instruments. Independently Operated Annunciators.

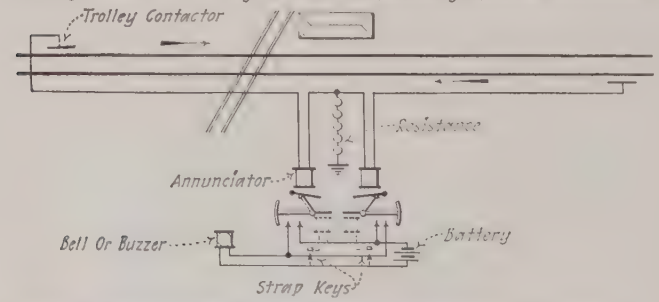
FIG. 345.—Wiring diagrams of railway annunciator circuits Nos. 5105, 5106 and 5107 respectively. (CHICAGO RAILWAY SIGNAL AND SUPPLY CO., Section A.)



I-Double Track With Track Instruments. Independently Operated Annunciator

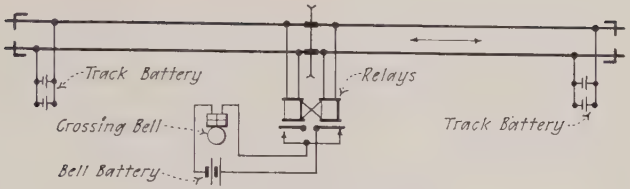


II-Single Track With Trolley Contacts. Independently Operated Annunciators

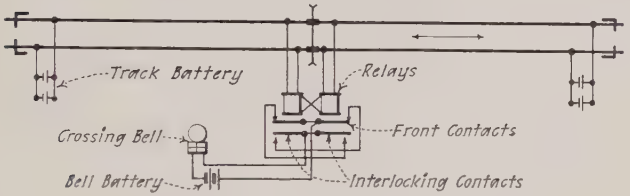


III-Double Track With Trolley Contacts. Independently Operated Annunciators

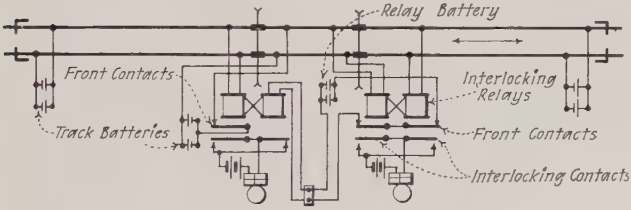
Fig. 346.—Wiring diagrams of railway annunciator circuits for the operation of crossing-signal alarms. Nos. 5108, 5109 and 5110 respectively. (Chicago Railway Signal and Supply Co., Section A.)



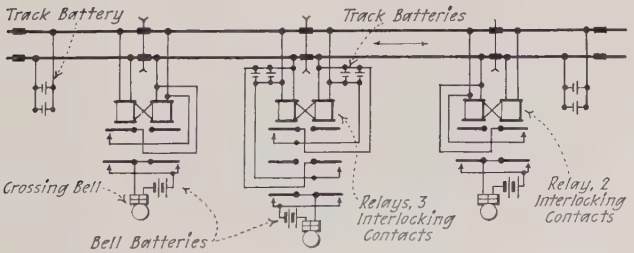
I-Single Track With Track Circuit



II-Single Track With Track Circuit



III-Single Track With Track Circuits And Two Crossing Bells



IV-Single Track With Track Circuits And Three Crossing Bells

FIG. 347.—Wiring diagrams of railway highway crossing alarm circuits Nos. 5001, 5002, 5003, 5004 and 5005, respectively. (CHICAGO RAILWAY SIGNAL AND SUPPLY CO., Section E.)

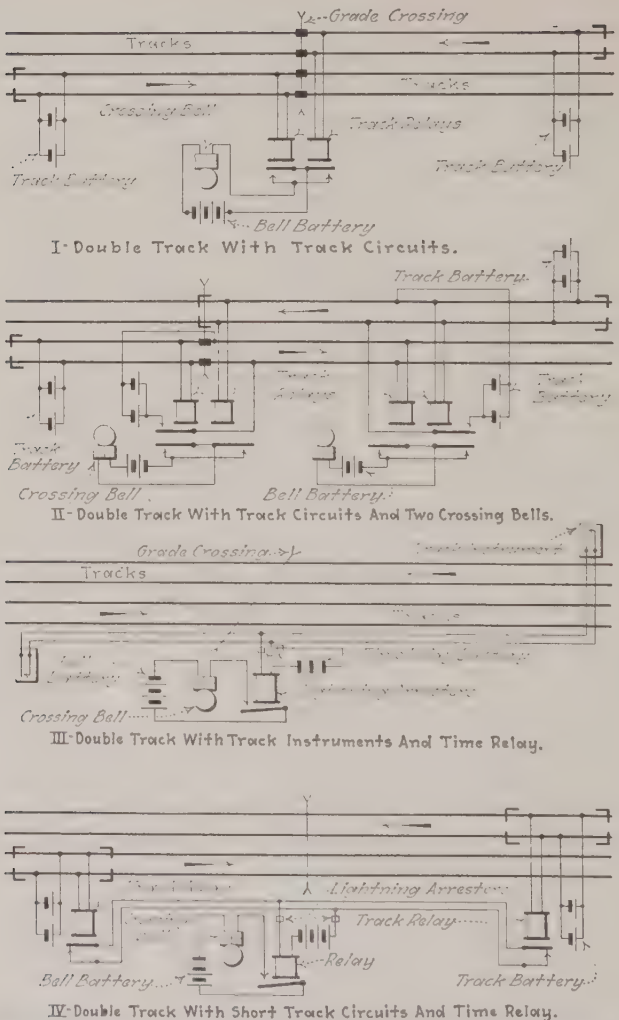
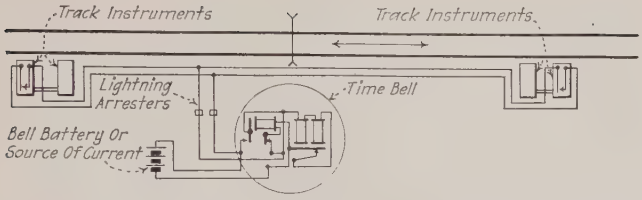
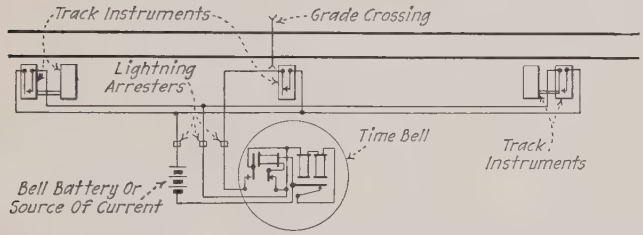


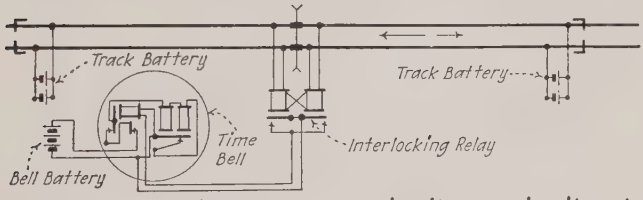
Fig. 348.—Wiring diagrams of railway highway crossing alarm circuits Nos. 5010, 5011, 5014, and 5016, respectively. (Chicago Railway and Signal Supply Co., Section E.)



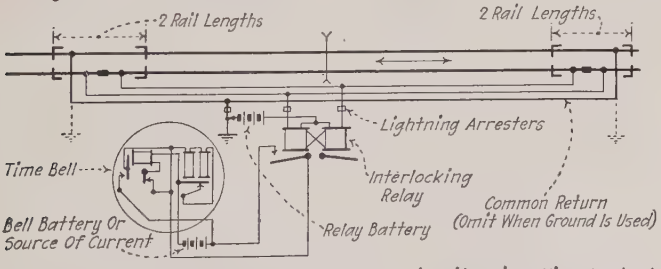
I-Single Track With Time Bell And Track Instruments. Line Wire Control



II-Single Track With Time Bell And Track Instruments. Line Wire Control—



III-Single Track With Time Bell And Track Circuit. Track Circuit Control



IV-Single Track With Time Bell And Short Track Circuits. Line Wire Control

FIG. 349.—Wiring diagrams of railway highway crossing alarm circuits Nos. 5017, 5018, 5019 and 5020, respectively. (CHICAGO RAILWAY SIGNAL AND SUPPLY CO., Section E.)

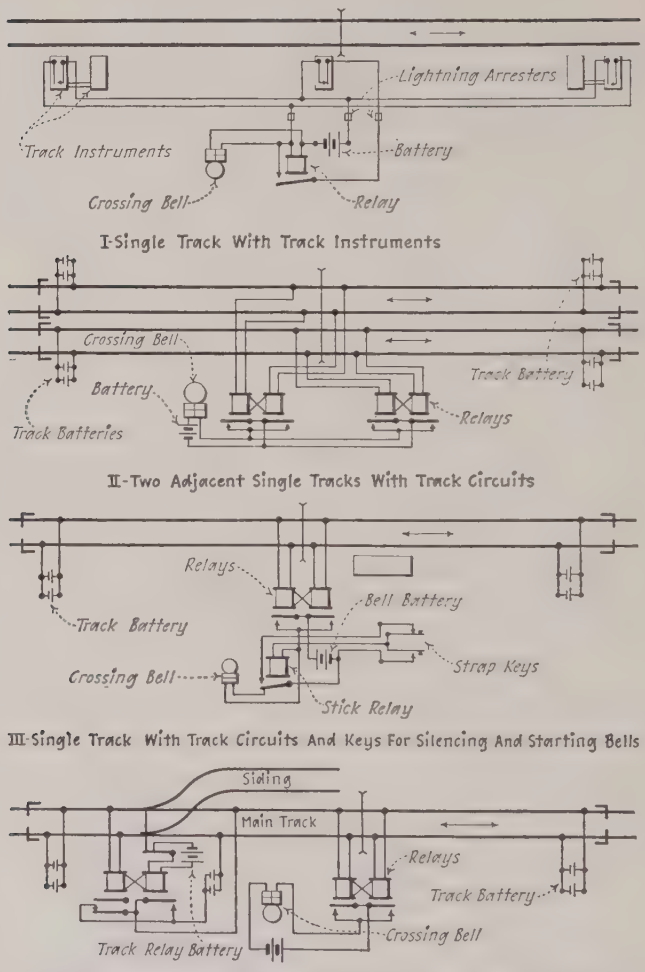


Fig. 350.—Wiring diagrams of railway highway crossing alarm circuits Nos. 5012, 5009, 5006 and 5008 respectively. (Chicago Railway Signal and Supply Co., Section E.)

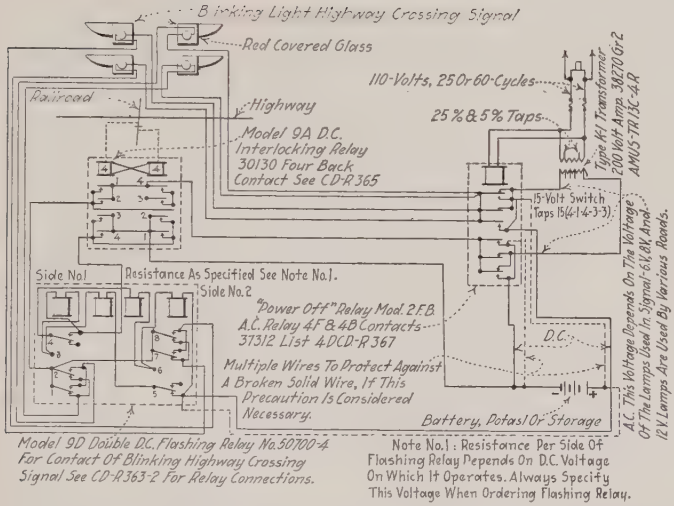

Blinking Light Highway Crossing Signal
Red Covered Glass
110-Volts, 25 Or 60-Cycles
Railroad
Highway
25% & 5% Taps
Model 9A D.C. Interlocking Relay 30130 Four Back Contact See CD-R 365
Type H1 Transformer 200 Volt Amp. 30270 Gr 2 AMUS-TR 13C-4-A
15-Volt Switch Taps 15(4-1-4-3-3)
Side No.1
Resistance As Specified See Note No.1.
Side No.2
"Power Off" Relay Mod. 2 F.B. A.C. Relay 4F & 4B Contacts 37312 List 4 DCD-R 367
D.C.
Multiple Wires To Protect Against A Broken Solid Wire, If This Precaution Is Considered Necessary.
Battery, Potasl Or Storage
A.C. This Voltage Depends On The Voltage Of The Lamps Used In Signal - 6 K.W. Arnd. 12 V. Lamps Are Used By Various Roads.
Model 9D Double D.C. Flashing Relay No. 30700-4 For Contact Of Blinking Highway Crossing Signal See CD-R 363-2 For Relay Connections.
Note No.1: Resistance Per Side Of Flashing Relay Depends On D.C. Voltage On Which It Operates. Always Specify This Voltage When Ordering Flashing Relay.

FIG. 351.—Wiring diagram for a highway-crossing-signal blinking-light circuit. Arrangement for alternating-current operation and battery reserve system is provided. (GENERAL RAILWAY SIGNAL CO.)

DIVISION 14

MISCELLANEOUS SIGNALING CIRCUITS

DIVISION 14

MISCELLANEOUS SIGNALING CIRCUITS

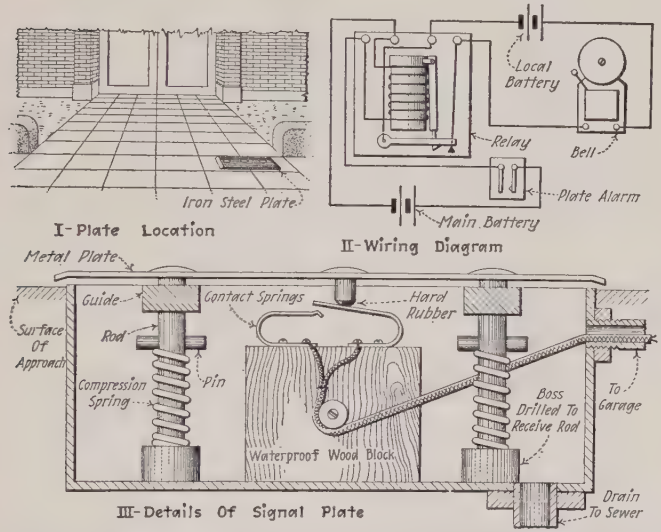


FIG. 352.—Garage alarm which signals the garage attendant when the car arrives at the door. This system eliminates much annoyance to the neighbors by the practice of drivers loudly sounding their horns when they desire to call the garage attendant.

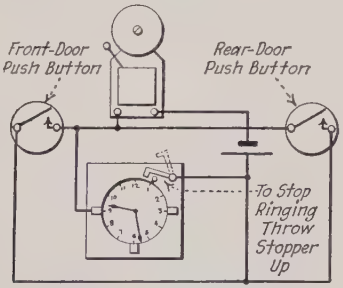


FIG. 353.—A combination front and back door and time alarm-bell. When the "stopper" is in the down position, each time the alarm-clock tapper strikes the stopper it rings the electric vibrating bell, which may be in a room distant from the alarm clock. Throwing the stopper up will cause the vibrator bell to cease ringing.

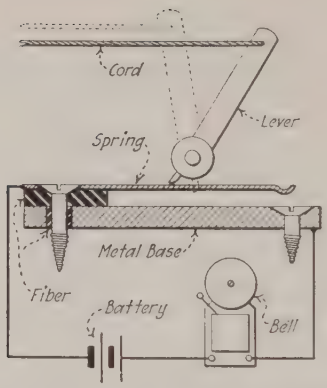


Fig. 354.—A door pull attachment whereby the old form of mechanical lever pull bell may be changed into an electric bell.

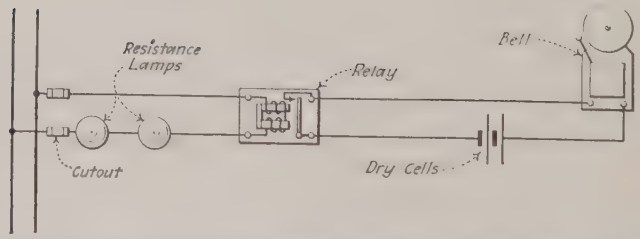


Fig. 355.—Tell-tale bell circuit connections for lighting circuit. When the lighting circuit is energized, the alarm is sounded.

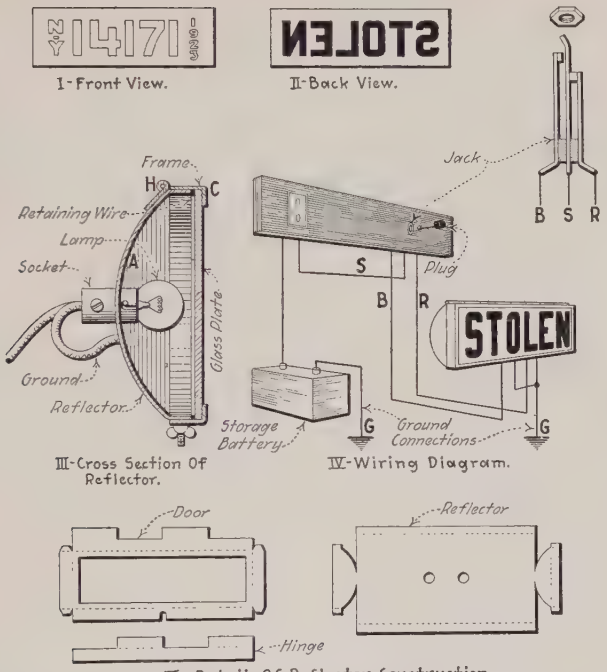


FIG. 356.—Illustrating a silent auto-alarm signal. The device consists of a metal reflector *A*, *III*, on the front of which a frame *C* is hinged at *H*. Two lamp receptacles are mounted on the reflector. The frame carries a glass plate of the same dimensions as the license plate, using a semi-opaque white for a background and a transparent red for the figures. On the inside the letters *Stolen* are painted with a transparent blue. Two lamps, one red and one blue are placed in the receptacles. One lead *G*, *IV* from each lamp is grounded through the body of the car to the battery. The other two lamp wires are connected to a three-spring jack mounted on the dash board. The third wire from the jack completes the circuit through the ignition switch. When the car is in use, the plug is inserted in the jack, thus lighting the blue lamp and causing the license to appear as black figures on a blue field.

When the car is left parked, the plug is removed so that upon closing the ignition switch by the would-be thief, the circuit through the red lamp is completed. The background then becomes red; the red license numbers, being invisible on a red field, disappear, their place being taken by the word "*stolen*" in large black letters. (*Practical Electrics*, Oct. 1923.)

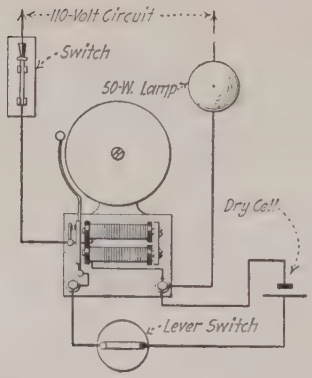


Fig. 357.—An improvised power-failure alarm. Normally, the power current through the bell magnets holds the bell armature against the magnet poles and prevents the bell from ringing. But when the power supply fails the armature is released and the bell will ring. When the power supply is alternating current, it may be necessary to mount the bell on rubber or cork to prevent the transmission of hum. This arrangement is contrary to the provisions of the *National Electrical Code* unless the bell is one which is of a design which is approved for operation on the power-circuit voltage.

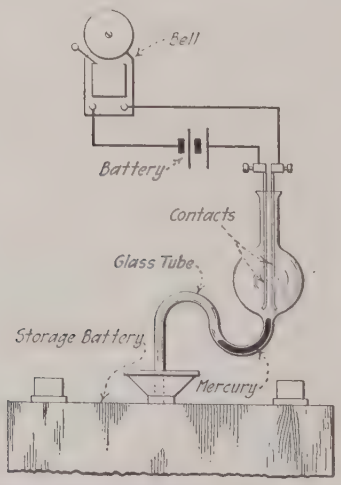


Fig. 358.—A battery charging indicator. The operation of the indicator depends upon the pressure of the gas produced by the battery during the process of charging.

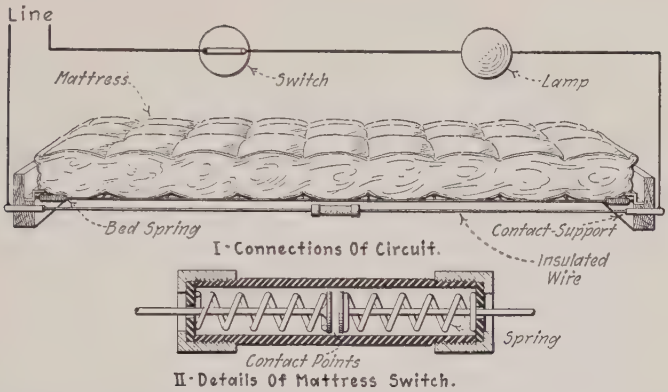


FIG. 359.—A home-made arrangement which lights an electric lamp when the wakeful occupant of the bed arises. As long as he stays on the mattress the light is extinguished. This arrangement would probably not be passed by an Insurance Underwriters' wiring inspector.

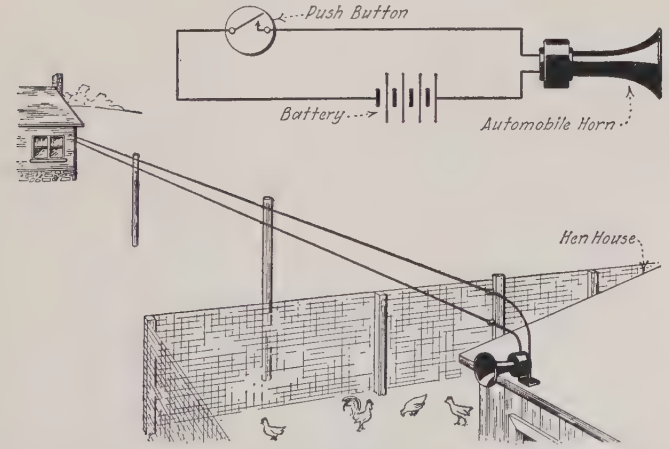


FIG. 360.—An automobile horn used to scare hawks away from the chicken yard.

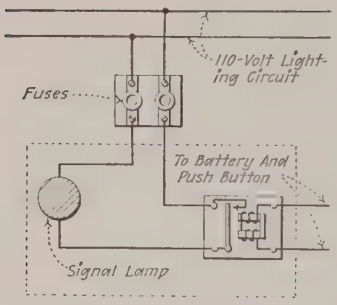


Fig. 361.—Connections for 110-volt lamp signal, using a bell magnet as a relay. This arrangement would probably not be approved by Underwriters' Inspectors unless the relay was carefully constructed and insulated for 110-volt operation. (*Power*, March 15, 1921.)

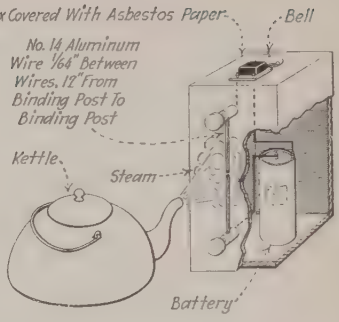


Fig. 362.—A teakettle alarm. When the steam from the kettle expands the metal strips, they touch and close the alarm circuit.

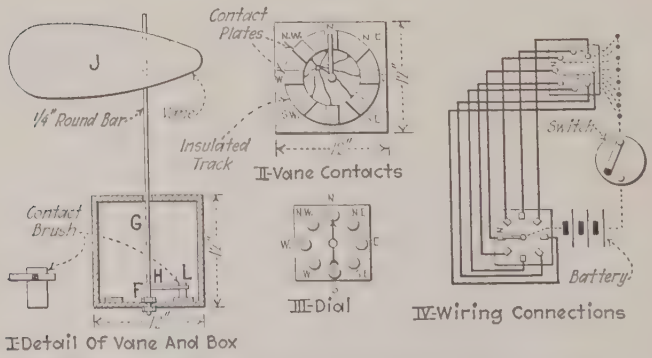


Fig. 363.—An electric weather vane which indicates the direction of wind on a dial located at a convenient point. The vane *J* is supported by shaft *G* pivoted at *F*. At arm *H* is welded to *G*, 1½ in. from the bottom, to which is attached a brush *L*. The brush *L* slides over a series of contact plates so arranged and wired to operate magnets on the dial, corresponding to the position of the vane. (*Modern Mechanics.*)

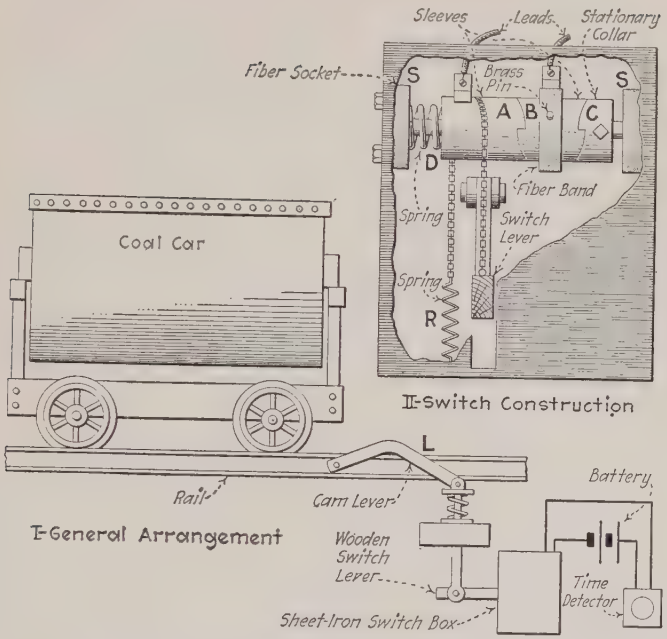
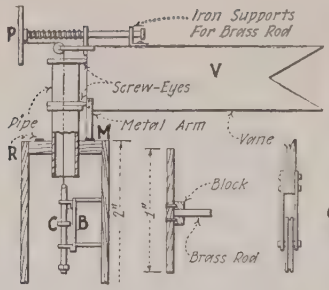
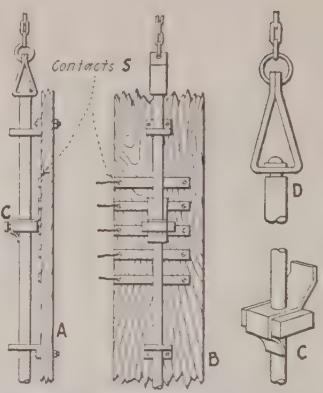


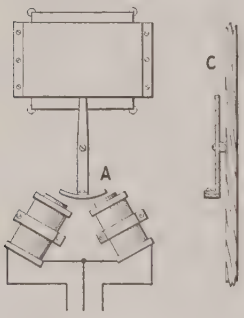
FIG. 364.—A device for recording trips of a coal car to boiler house. On the trip in the car wheels depress the cam lever (*L*) which actuates a switch lever mechanism completing the circuit to a time detector which records the trips; since the wheels depress the cam lever twice on the in trip and twice on the out trip, a special switching mechanism has been devised so that the cam lever must be depressed four times for each time an indication is made on the record. A study of the switch construction in (*II*) will reveal the method of obtaining this cycle of contact. Upon a brass rod, supported in two fiber sockets *SS*, are mounted two brass sleeves "*A*" and "*B*" free to move on the brass rod. The contiguous ends of these sleeves are notched to form a four-tooth ratchet clutch. The right-hand sleeve engages with a stationary tooth collar "*C*." A spring *D* holds the sleeve teeth in mesh. Around sleeve "*B*" a fiber band is fitted through which projects a small brass pin. When the lever is depressed the sleeves are given a quarter turn by the pull of the chain which connects the switch lever with the left hand sleeve. When the lever is released the left-hand sleeve "*A*" is pulled back to its first position by spring *R*, but the right-hand sleeve, *B* is kept from turning back by the clutch on the stationary collar (*C*). Since there are four teeth in the sleeve, four depressions of the lever are required for one revolution of the sleeve carrying the contacting making pin. (*Industrial Engineer*, May, 1924.)



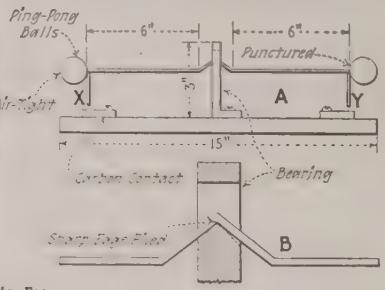
I-General Arrangement Of Exterior Mechanism Of Weather Forecaster



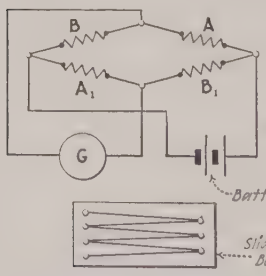
II-Sliding Contact Device Used In Connection With Wind Pressure Indicator



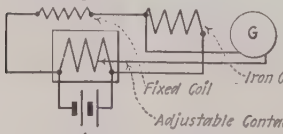
III-Arrangement Of The Magnets For Barometer On Back Of Indicating Board



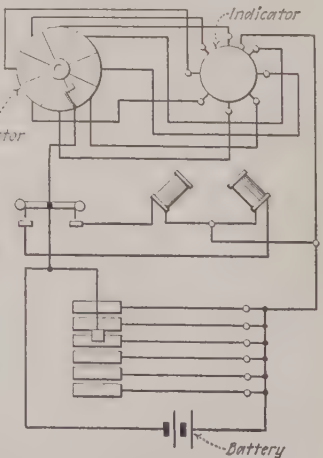
IV-A Simple Barometer



V-Thermometer Circuit Employing A Wheatstone Bridge



VI-Connections For Thermometer Operating On The Slide Wire Principle



VII-Connections Of Complete Apparatus

Fig. 365.

Fig. 365.—Illustrating an electrically-operated weather indicator. The condition of wind, temperature and humidity can also be indicated. In *I* and *II* the general arrangement of the wind-pressure and direction-indicating mechanisms are diagrammed. The wind-direction indicator functions by virtue of a metal arm *M*, Fig. *I*, bolted to the vane *V*. The metal arm slides over contacts *R*, closing a circuit through an indicator. The wind-pressure indicator is operated by the action of the wind against a disc *P*, Fig. *I*, which actuates the sliding contact device shown in *II*. In *III* and *IV* is shown the humidity-indicating device, the principal parts of which are two small celluloid balls balanced on a contact making arm. One of the balls is airtight and the other is punctured. Hence, the weight of the air-tight ball will remain constant while the weight of the punctured ball will vary with the humidity of the air. By virtue of the foregoing, when the humidity is low the contacts at *X*, Fig. IV are completed, while a high humidity will increase the weight of the air in the punctured ball, with the results that contacts *Y* are closed. These contacts are connected to an indicator, Fig. *III*. The electric thermometer Figs. *V* and *VI* operates on the Wheatstone-bridge principle. The galvanometer is calibrated to indicate degrees Fahrenheit. The bridge consists of two sets of resistance coils, having different temperature coefficients. The bridge is balanced at 60°F., so an increase or decrease in temperature unbalances the bridge causing the galvanometer to deflect. For resistance coils having a low temperature co-efficient use magnesium or constantin wire, and for the high temperature co-efficient coils use iron wire. About 40 ft. of 30 B.S. gage wire per coil will suffice. Connections of the complete apparatus is shown in Figs. *VI* and *VII*. (*Everyday Engineering.*)

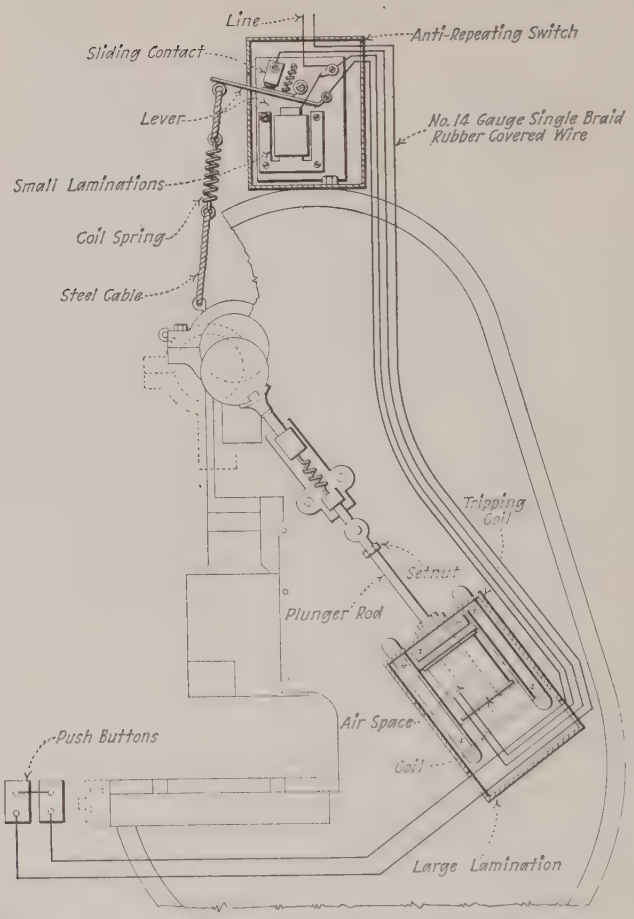


Fig. 366.—Installation and wiring diagram for The Electro Safety Punch-press Guard. In this arrangement, the tripping mechanism is actuated by an electro-magnetic coil instead of a foot treadle. The electro-magnet is operated by push buttons. On the one-man press (shown above), two push buttons are provided. Both buttons must be pressed before the magnet operates. It is therefore necessary for the operator to have both hands free from danger before the press can be operated. An anti-repeating switch is also provided. Wiring diagrams for two- and for four-men presses are shown in the following illustration. (The Safety Equipment Service Co., Cleveland, Ohio.)

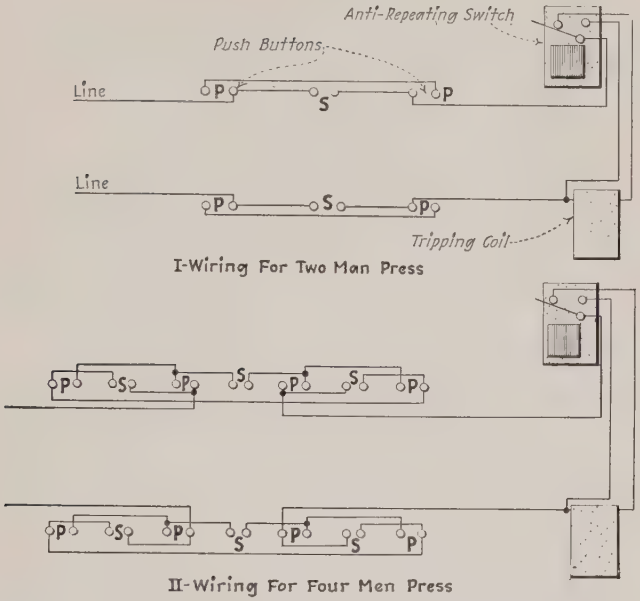


FIG. 366A.—Wiring diagrams for the Electro Safety Punch-press Guard for two-men and four-men presses. See preceding illustration for mechanism.

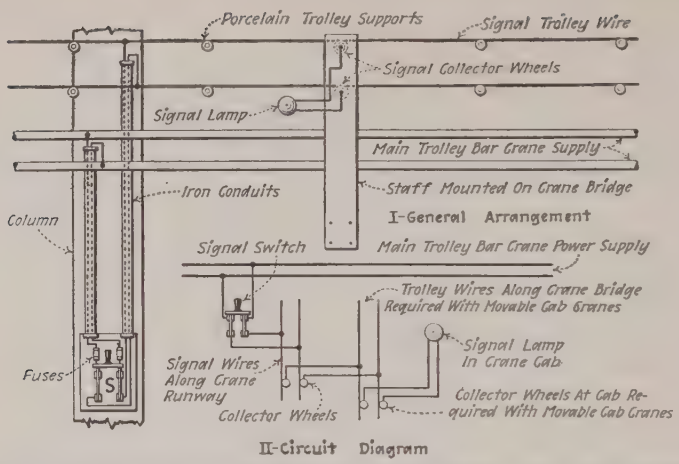


Fig. 367.—Signal system used to call a crane operator from any part of the bay. If the cab is movable, two sets of trolley wires and wheels must be used as shown in *II*. One set of wires runs the length of the crane runway or bay and the other set runs along the crane bridge across the bay. The signal lamp is in the cab. If the cab is not movable, the second set of trolley wires is omitted. A number of switches, *S*, are installed at convenient locations along the bay. When a man on the floor in the bay wants the crane, he closes the nearest switch, *S*. This lights the signal lamp in the crane cab, advising the crane operator that the services of the crane are required. (*Industrial Engineer*, Sept., 1922.)

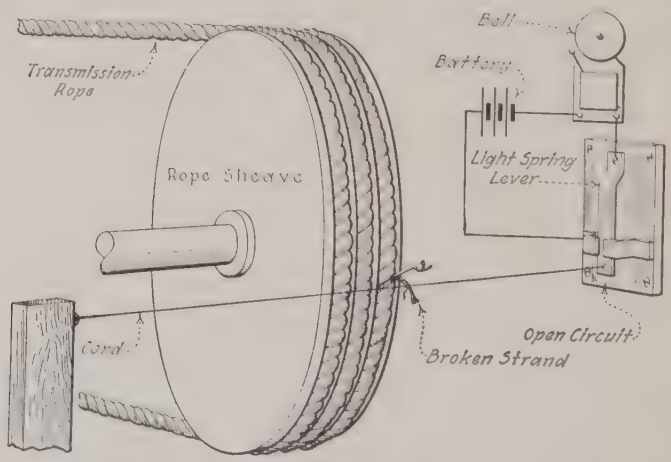


Fig. 368.—An electric alarm signal for rope transmissions. A broken strand in the rope strikes the wire, thereby causing an electric contact to be made, which closes an alarm circuit.

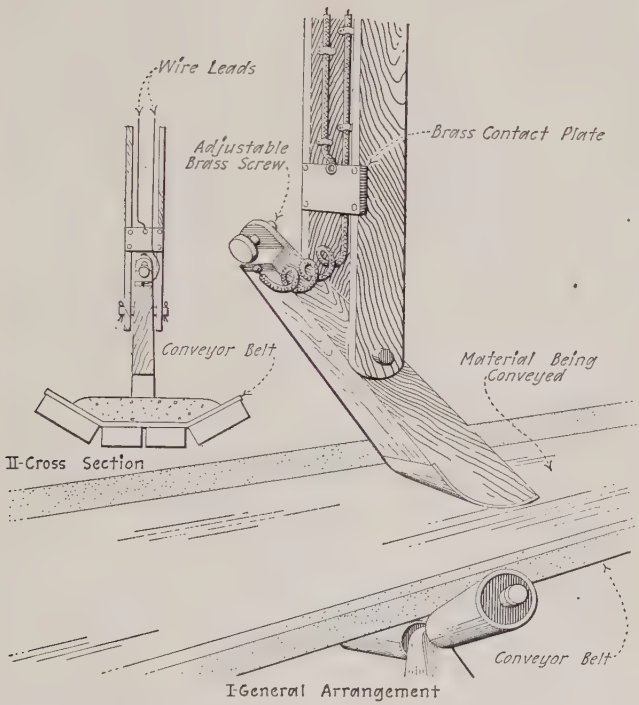


FIG. 369.—An alarm-bell contactor for a belt conveyor. This device indicates the discontinuance of the stream of material upon a moving conveyor belt, by the sounding of an alarm bell. (*Engineering and Mining Journal.*)

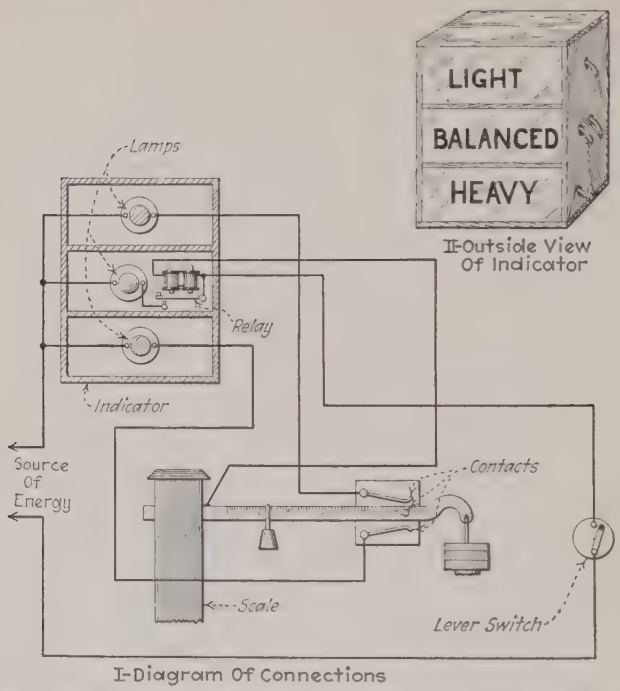


Fig. 370.—A simple signaling apparatus for indicating when the load on a scale is too heavy, too light or balanced. (*Practical Electrics*, Jan., 1923.)

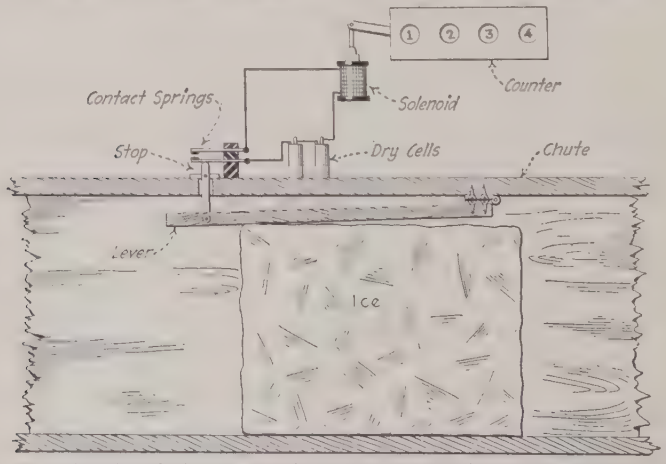


Fig. 371.—An electrically-operated counter attached to an ice chute. The counter can be located in a room far distant from the chute.

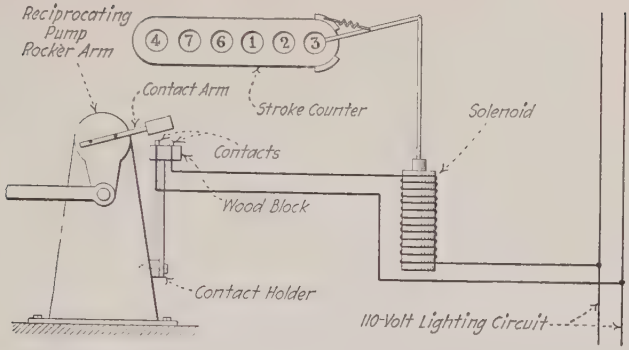


FIG. 372.—Connections for an electrical stroke counter on a reciprocating pump. The stroke counter may be located at a point far distant from that at which the pump is in operation.

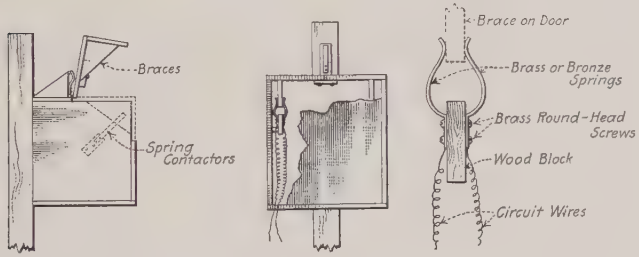


FIG. 373.—Mail box arranged with momentary contact alarm.

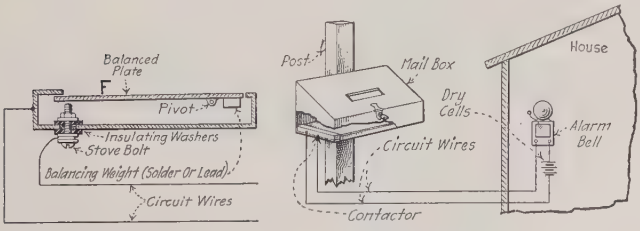


FIG. 374.—A mail-box-alarm contactor which is so constructed that it will sound an alarm when the lightest possible piece of mail matter is deposited in the box. The contact making device consists of a balanced plate *F* located in the bottom of the mail-box.

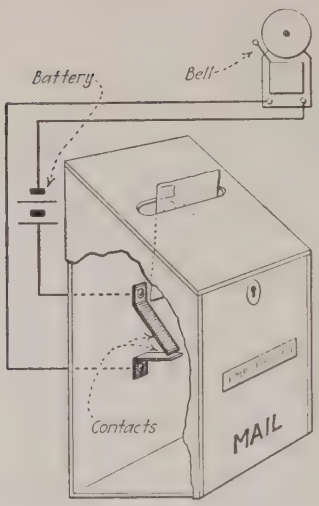


Fig. 375.—A letter-box alarm which gives a signal on a distant electric bell by an electric contact being made when a letter is dropped into the box.

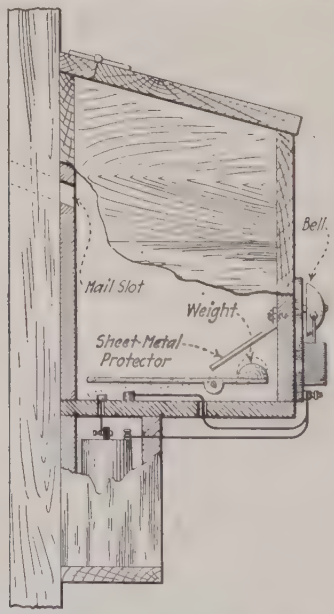
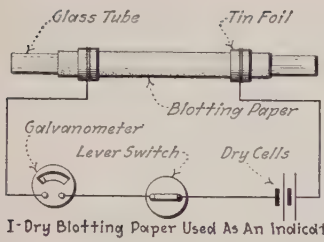
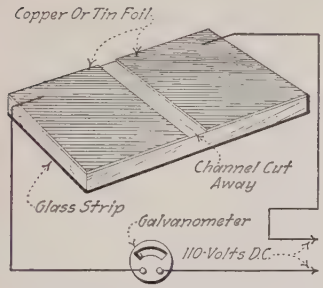


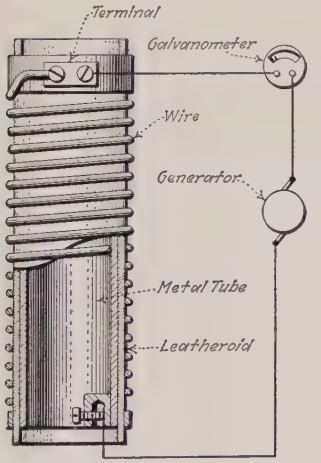
Fig. 376.—An alarm-sounding mail box; when mail is dropped in the box, the bell rings.



I-Dry Blotting Paper Used As An Indicator.

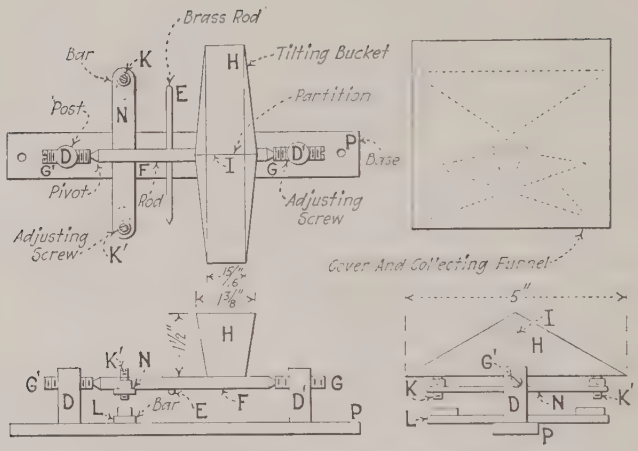


II-Glass Plate Used In Moisture Indicator.

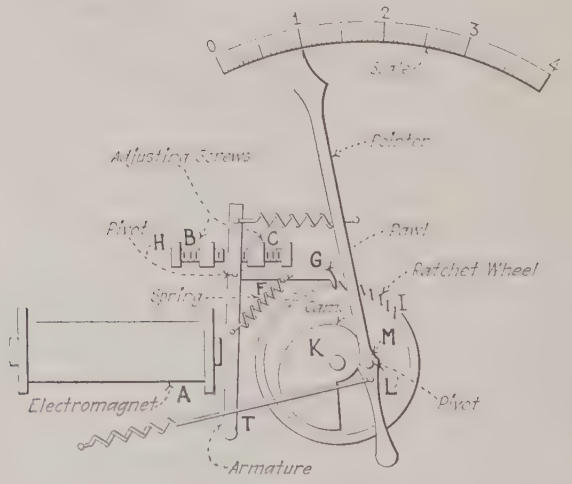


III-Presspahn Used In Indicator.

FIG. 377.—Electrical moisture indicators. In *I*, a glass rod is covered with white blotting paper and moistened with a zinc chloride solution. Tin foil electrodes are affixed near the ends of the blotting paper, and are held in place by means of bare copper wires twisted around them. In *II* the accumulation of moisture on the glass between the tin foil strips closes an electric circuit through a galvanometer. In *III* is shown a moisture indicator of British manufacture, using presspahn, or artificial leather, leatheraid or a similar material as the absorbing medium for the moisture. The device consists of a metal tube upon which is wound a layer of presspahn. A spiral of wire is wound around the hygroscopic leather covering and a potential from a generator causes a current to flow through the indicator when moisture is present. (*Practical Electrics*, Feb., 1923.)



I-Tilting Bucket And Stand. Bucket Dimensions Given



II-Arrangement Of The Rainfall Indicator Mechanism

Fig. 378.

FIG. 378.—An electrically recording rain gauge. Upon the base *P*, are mounted posts *D* and *D'*, carrying centered screws *G* and *G'*. The pointed rod *F'* is pivoted between these screws so as to rotate freely. The tilting bucket *H*, which is divided vertically through the center by partition *I*, is soldered or otherwise fastened near one end of the rod *F*. This bucket is built up of some thin, light, non-rusting metal. The rod *F* also carries a light brass rod *E* which makes contact, at the middle of its stroke as the bucket tips, with a contact spring (not shown). This contact completes an electrical circuit through the electromagnet *A*. Also there is provided a bar *N* having screws, *K*, at the ends, for the purpose of adjusting the tilting of the bucket. Bar *L* is fixed to the base directly under the bar *N* and acts as stops for the adjusting scress *K* and *K*1. The recording mechanism, *II*, consists of an armature *T* actuated by an electromagnet, *A*, the stroke of which is adjusted by screws *B* and *C*. The pawl *G*, which is hinged to armature *T* at *H*, is held in contact with a fine-toothed rachet wheel *I* by a very light spring *F*. On the same shaft with the ratchet is fixed a cam, *K* which when rotated moves the pointer across the scale. The scale may be calibrated to read inches rainfall. The pointer is pivoted at *L* and a small roller at *M* rides against the cam *K*. A large clock gear may be substituted for the rachet wheel. (*Everyday Engineering.*)

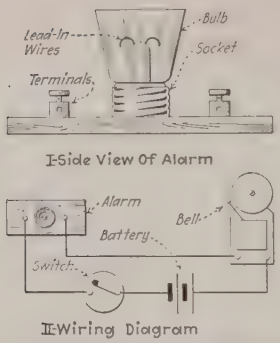


Fig. 379.—Diagram of a rain alarm constructed from an old electric-lamp bulb. (*Popular Science.*)

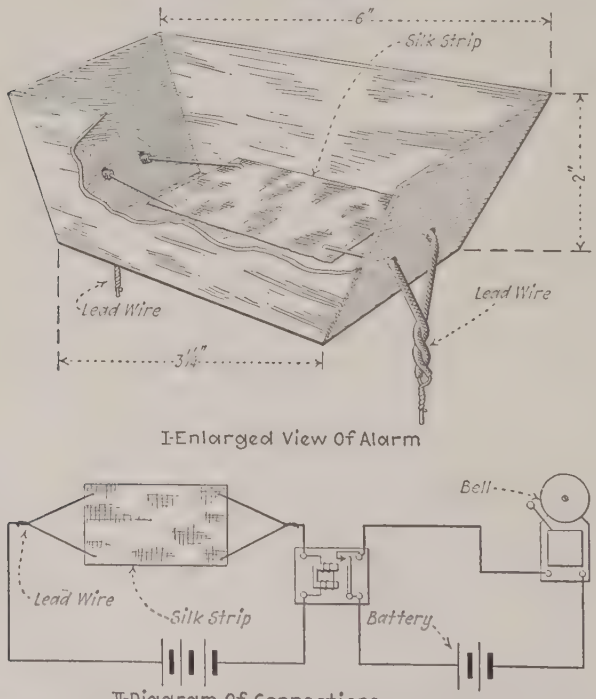


Fig. 380.—A rain or snow alarm. The alarm consists of a strip of silk cloth suspended between two wires which complete a circuit through a bell and battery. The apparatus is inclosed in a small box for protection against wind. A small amount of common salt is spread upon the silk. When snow falls upon the silk, it is immediately melted by the salt, moistening the silk strip and causing it to become a conductor. (*Popular Science.*)

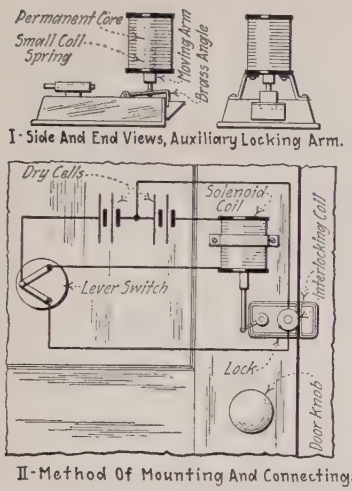


FIG. 381.—A combination secret electric lock. Two solenoids are used, one to turn the latch spindle, the other to release the locking arm. A secret switch operates the solenoids.

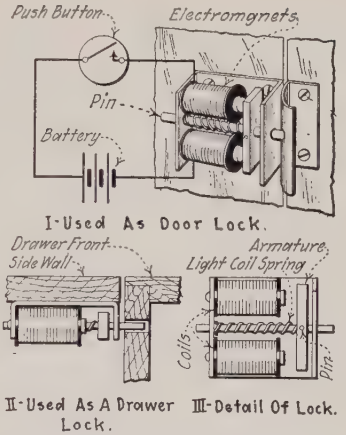


FIG. 382.—An electric bolt lock constructed from an electric bell.

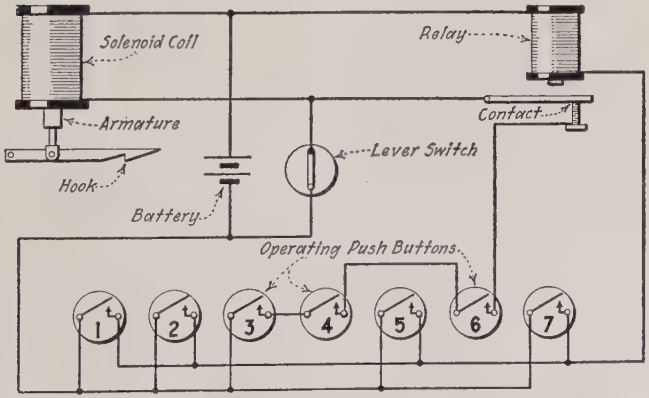


FIG. 383.—A puzzling electric lock which requires the proper combination of buttons to be pressed in order to open the lock.

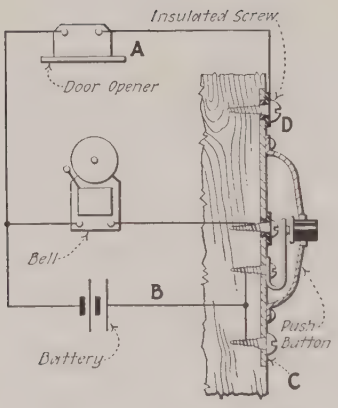


Fig. 384.

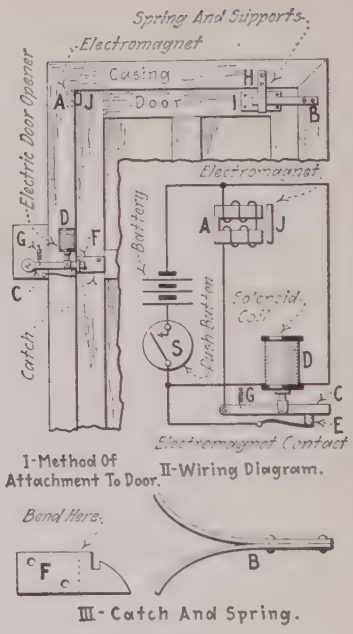


Fig. 385.

Fig. 384.—Connections of a secret contact for operating an electric door switch. One side of the battery "*B*" is grounded to the frame of the push button, "*C*" through the door opener "*A*" at an insulated screw "*D*" which fastens the push-button to the door frame. Anyone who knows the secret connection can operate the door lock by touching the insulated screw and the push button frame with a piece of metal such as a ring, which closes the door-opener circuit permitting the door to open.

Fig. 385.—Illustration of a home-made electrically operated door opener. When the secret switch *S* is closed, the electromagnet, *A* draws the door tightly against its jamb. The electro magnet *A* is mounted near the top of the door casing and a bar of iron *J* is fastened to the door in such a manner that it is attracted by the electric magnet *A*. This releases the friction from the bar *C* caused by the compressed spring *B*, which throws the door open after the bar *C* has cleared the catch *F*, and broken the circuit of the electro magnet *A* at the contacts *E* by the action of coil *D*. The spring *G* should be adjusted to nearly compensate for the weight of the core, so that the bar *C* will rest lightly in the catch *E*.

DIVISION 15

BATTERIES, TRANSFORMERS, AND SIGNALING DEVICES

DIVISION 15

BATTERIES, TRANSFORMERS, AND SIGNALING DEVICES

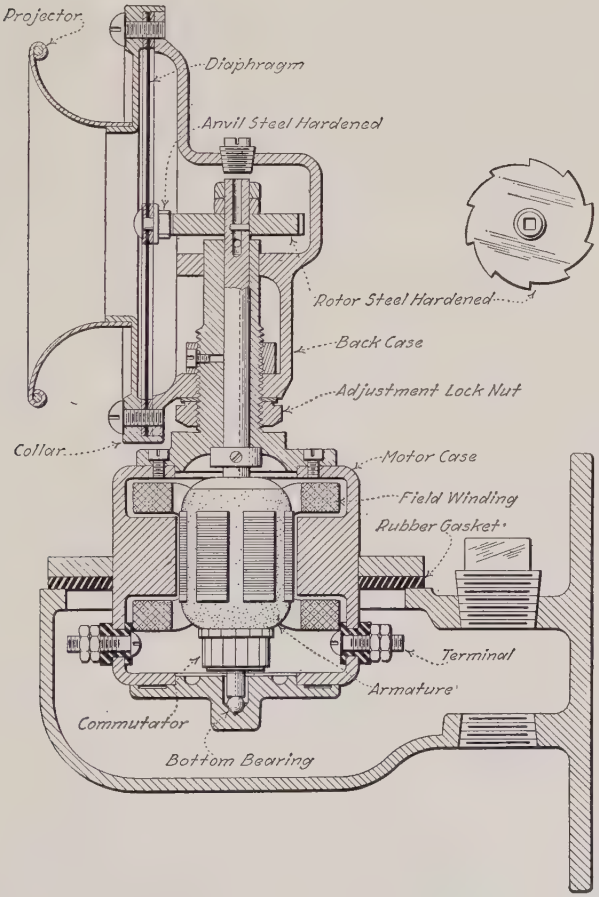


FIG. 386.—Diagram showing a cross section of a horn signal used with a factory signal system. (KLAXON CO., Newark, N. J.)

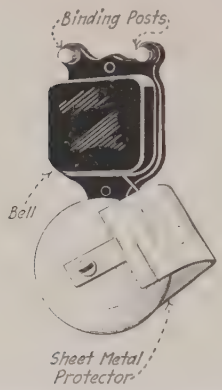


Fig. 387.—A simple protecting device for electric bells. Frequently the gong hammer is pulled out of place in cleaning or dusting so that it fails to strike; the protector shown eliminates this possibility.

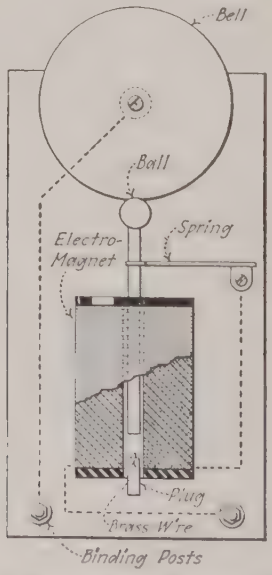


Fig. 388.—A simple vibrating electric bell which can be easily constructed. The "make and break" occurs between the tapper ball and the gong. Current passing through the solenoid pulls down the plunger. Thereby the circuit is opened at the "make and break," which permits the spring to again raise the plunger.

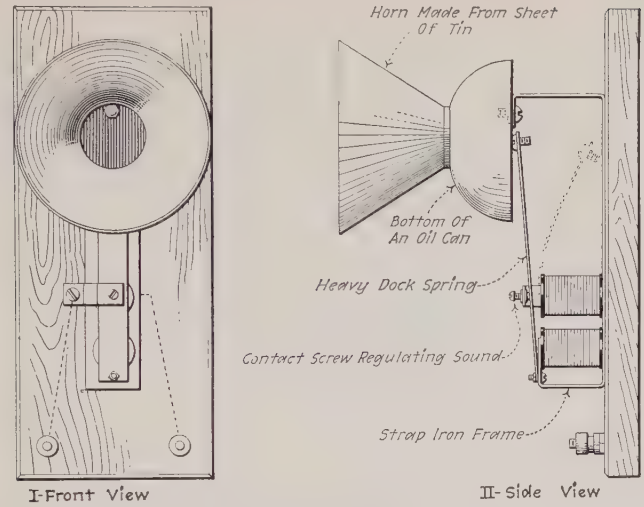


FIG. 389.—An improvised simple and practical electric horn which may be made from odds and ends.

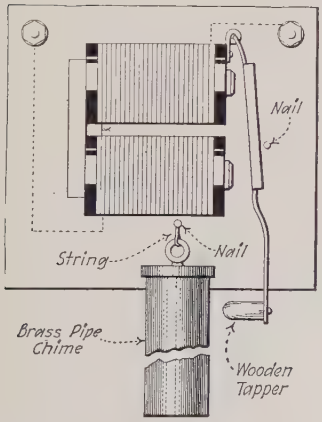


FIG. 390.

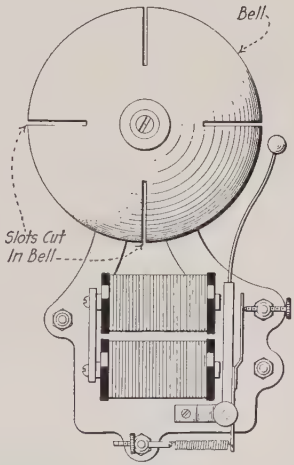


FIG. 391.

FIG. 390.—An easily constructed single-stroke chime ringer. An ordinary bell movement may be utilized by removing its interrupter. This arrangement may be used for sounding time by connecting it in a circuit which is closed by a contactor on the strike arm of a clock. The tapper and armature are so balanced that, normally, gravity holds the tapper away from the chime.

FIG. 391.—Slotting the gong of an electric bell to change its tone.

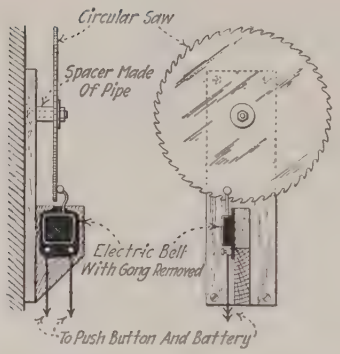


Fig. 392.—Discarded circular saw converted into a powerful audible signaling device by combining it with the mechanism of an electric bell.

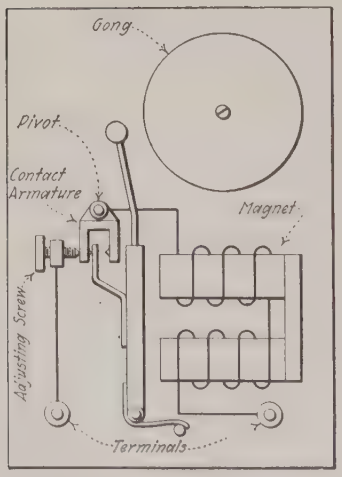


Fig. 393.—An arrangement for making a bell ring with very slow frequency, by the use of a fork-type make and break connection.

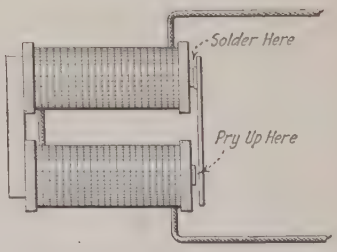


Fig. 394.—Constructing an alternating-current buzzer from old bell magnets. (*Popular Science Monthly.*)

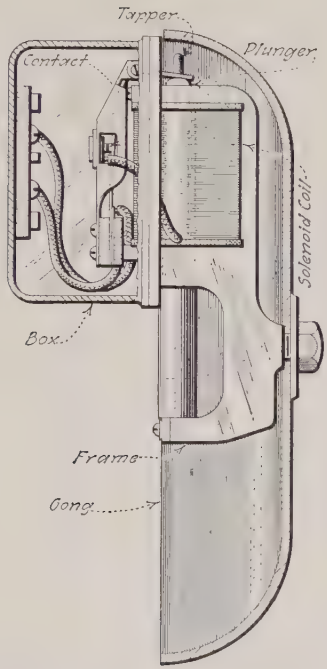


Fig. 395.—Illustrating the "Signal" bell. This vibrating bell has minimum moving parts and mechanical trouble. The entire mechanism comprises only three moving parts: (1) *A solenoid plunger*, which strokes the gong. (2) *A spring contact.* (3) *An interrupter*, which is operated by the plunger. This bell is manufactured in 4 in., 6 in., 8 in., 10 in., and 12 in. sizes for all standard voltages, either alternating-current or direct-current. All of the bells mount on a "universal" conduit outlet box, which permits the installation of the bell for either open or concealed or conduit wiring. (*Signal Engineering Co.*, New York City.)

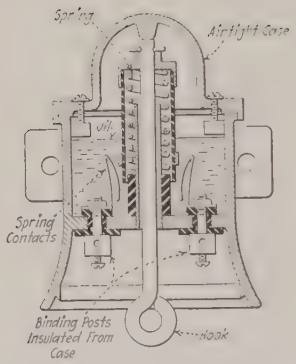


Fig. 396.—Cross-sectional view of the Colorado Mine Signal circuit-closer. The contacts are enclosed in an iron case which is completely filled with oil. (*Electrical Record*, May, 1920.)

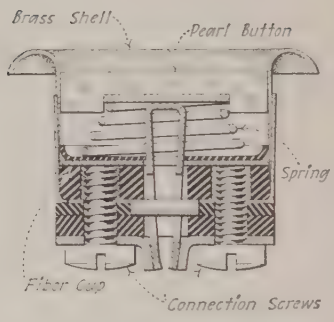


Fig. 397.—Sectional view of a Deveau midget type push button manufactured by Stanley and Patterson, New York. The actual diameter of the shell is 5/8 in. The button is shown in a partially-depressed position.

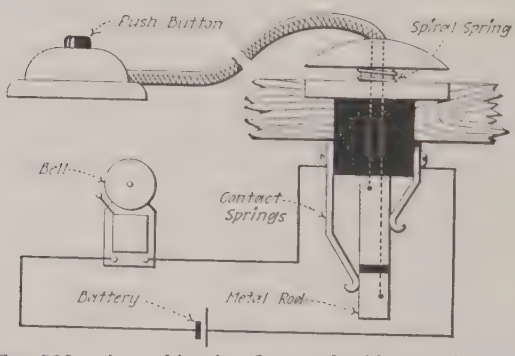


Fig. 398.—A combination floor-and-table push button.

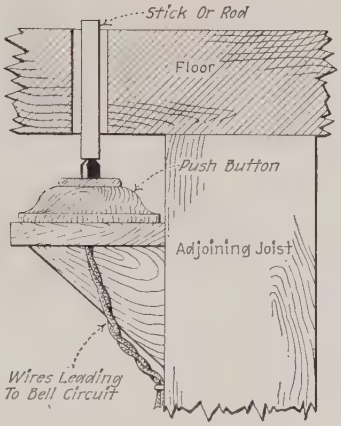


Fig. 399.—A home-made floor push button.

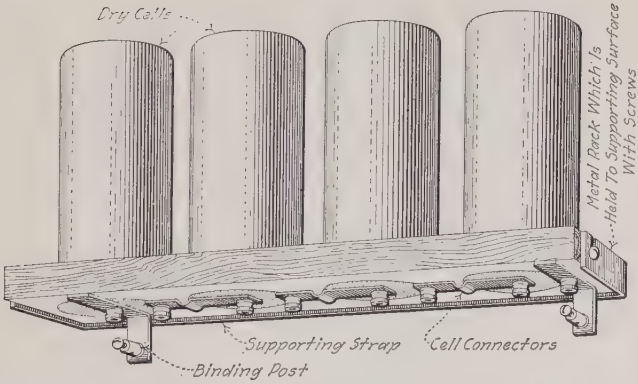


Fig. 400.—Rollinson battery rack manufactured by the Electrical Sales Co., Boston, Mass.

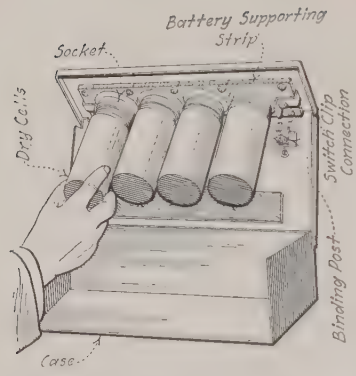


FIG. 401.—Illustrating a Patterson battery set.

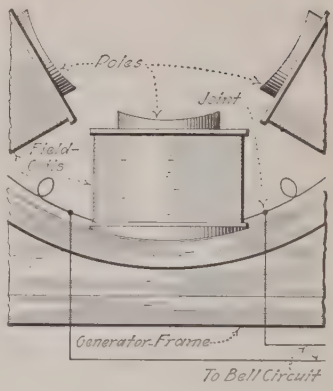


FIG. 402.—A method of obtaining a reduced direct-current voltage for the operation of signals adjacent to an engine room where direct-current generators are in operation.

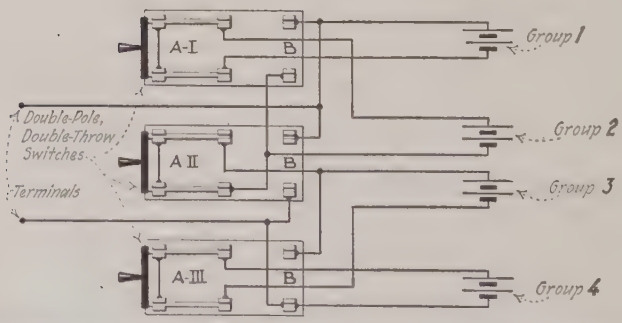


FIG. 403.—An arrangement of four sets of dry cells and three, double-pole, double-throw switches whereby any combination of 3, 6, 9 or 12 volts can be obtained. With all of the switches in their *A* positions, a pressure of 12 volts, is impressed on the terminals, and the four sets of batteries are in series. When all the switches are in their *B* positions, all the batteries are in parallel, with a potential difference of 3 volts across the terminals. With switch *I* in its *B* position, and *II* and *III* in their *A* positions, 9 volts is impressed across the terminals, while with switch *II* in its *B* position and switches *I* and *III* in their *A* positions, a potential of 6 volts is obtained across the terminals. By this arrangement all of the cells are always in service regardless of the voltage impressed on the terminals. (*Practical Electrics*, June, 1923.)

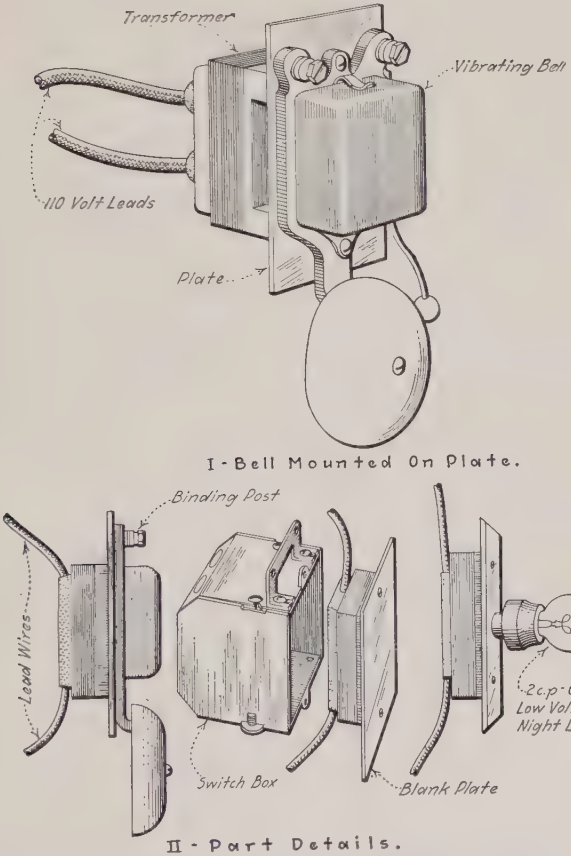


FIG. 404.—A Rittenhouse Type-SB bell-ringing transformer. It is designed for mounting in a single-gang switch box. (THE A. E. RITTENHOUSE CO.)

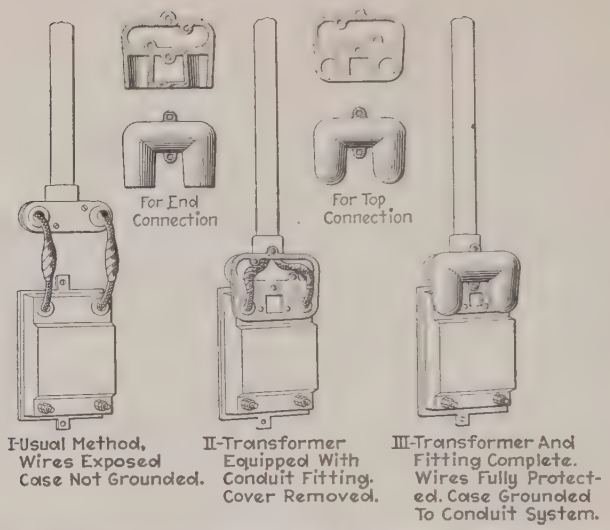

For End Connection
For Top Connection
I-Usual Method, Wires Exposed Case Not Grounded.
II-Transformer Equipped With Conduit Fitting. Cover Removed.
III-Transformer And Fitting Complete. Wires Fully Protected. Case Grounded To Conduit System.

Fig. 405.—A convenient conduit fitting for use in connection with the installation of bell-ringing transformers. (Dongan Electric Mfg. Co., Detroit, Mich.)

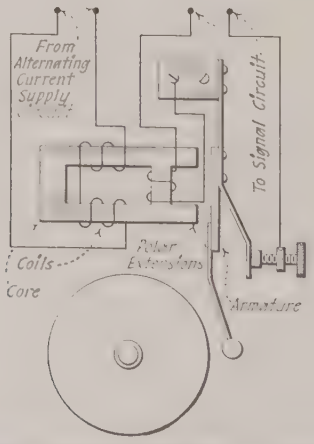


Fig. 406.—A combined bell and transformer. The core of the apparatus is so shaped as to provide two magnetic poles, which operate on an armature so as to ring the bell.

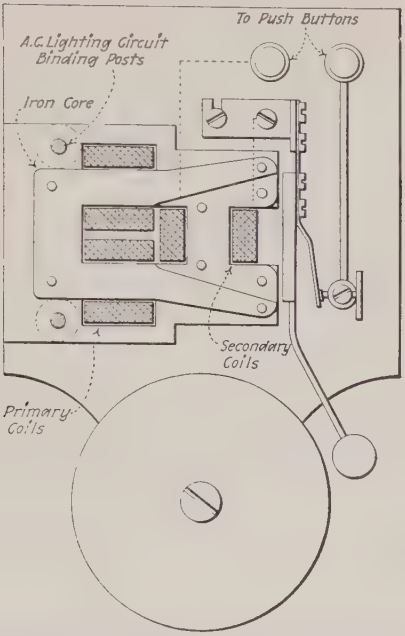


FIG. 407.—Door bell with built-in transformer. This arrangement is being manufactured in Germany. Complete winding and core data are given in *Elektrotechnic und Maschinenbau* for Apr. 23, 1922.

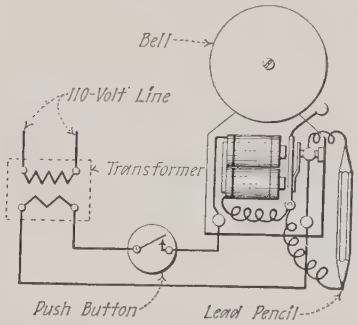


FIG. 408.—A lead pencil used to prevent bell contacts from sparking. The graphite of the pencil constitutes a high-resistance shunt around the bell contacts. (*Popular Mechanics.*)

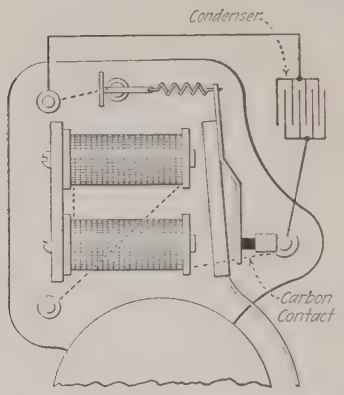


Fig. 409.—A carbon crossing-bell contact which has proved effective in eliminating sparking and blistering of the contacts. The condenser which is shunted around the contacts, charges and discharges as the armature vibrates and thereby eliminates excessive arcing at the contacts. (*Electric Railway Journal.*)

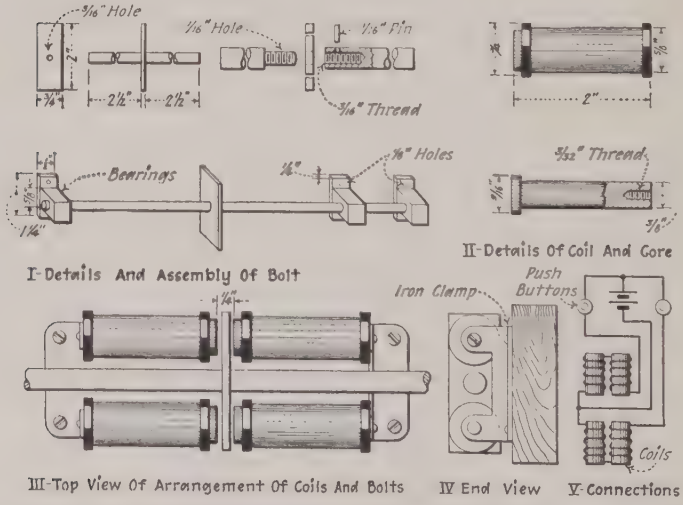


Fig. 410.—Constructional details of a remote controlled keyless lock.

DIVISION 16

SIGNAL-WIRING METHODS

DIVISION 16

SIGNAL-WIRING METHODS

1. The Rules Governing The Installation Of Signal Wiring As Required By The National Board Of Fire Underwriters In The 1925 "National Electrical Code," follows:

ARTICLE 60. SIGNAL SYSTEMS.

6001. General.

a. The provisions of this article shall apply to telephone, telegraph (except radio), district messenger, and call-bell circuits, fire- and burglar-alarm and similar systems.

Such systems are hazardous only because of their liability to become crossed with electric light, heat, or power circuits.

6002. Outside Wires.

a. Outside wires shall be placed in underground ducts or strung on poles. They shall not be run across or attached to roofs except by permission of the inspection department.

b. Underground wires shall not be placed in a duct, handhole, or manhole containing electric light or power wires. Where a handhole or a manhole is divided into sections by means of partitions of brick, concrete or tile, each compartment shall be considered as a separate handhole or manhole.

c. Overhead wires shall not be attached to a crossarm carrying electric light or power wires, nor shall they, when on the exterior walls of buildings, be brought closer than 4 in. to electric light or power wires unless one system is in conduit or is permanently separated from the other system by a continuous and firmly fixed non-conductor, additional to the insulation on the wires.

d. The metal sheaths of aerial cables which are liable to contact with electric light or power wires shall be interrupted close to the entrance to a building by an insulating joint or equivalent device.

e. The distance between the two inside pins of any crossarm of a pole carrying signal and electric light and power wires shall be not less than 24 in.

It is recommended that signal wires, being smaller and more liable to break and fall, be placed on the lower crossarms.

f. Aerial cables of the metal-sheathed type may have paper or other suitable insulation. If the metal sheath is omitted each wire shall have

$\frac{1}{32}$ in. rubber insulation and the bunched wires shall be covered with a substantial braid.

g. Wires from the last outdoor support to the protector, and wires attached to buildings, shall conform to the requirements of paragraph *f* of this section, and in addition shall carry a substantial braid on each wire. Where not in conduit, such wires shall be separated from woodwork and supported on glass or porcelain insulators.

h. Wires shall enter buildings either through non-combustible, non-absorptive, insulating bushings, or through approved rigid conduit. Conduit or bushings shall slope upward from the outside, or, where this cannot be done, drip loops shall be formed in the wires immediately outside the point of entrance. The conduit shall be equipped with an approved service head. More than one wire may enter through one conduit or bushing.

6003. In Buildings, Generally.

a. Wires beyond the protector or wires inside buildings where no protector is employed shall be neatly arranged and secured in place in a convenient, workmanlike manner. They shall not approach nearer than 2 in. to any electric light or power wire unless one system is in conduit or the two systems are permanently separated by a continuous and firmly fixed non-conductor, additional to the insulation on the wires.

The wires would ordinarily be insulated, but the kind of insulation is not specified, as reliance is placed on the protector to stop all dangerous currents. Porcelain tubes or approved flexible tubing are considered suitable non-conductors.

b. Wires bunched together in a vertical run shall have a fire-resisting covering sufficient to prevent the carrying of fire from floor to floor. This requirement shall not apply if the wires are encased in non-combustible tubing, or are located in a fireproof shaft having fire stops at each floor.

c. Signal wires and electric light and power wires may be run in the same shaft if the two systems are separated at least 2 in., or if either system is encased in non-combustible tubing.

d. Signal wires shall not be placed in a tube containing electric light or power wires.

6004. In Buildings, Where The Distribution System Consists Of Aerial Wires.

a. An approved protector shall be placed as near as practicable to the point of entrance to the building. The protector shall be mounted on a non-combustible, non-absorptive, insulating base and shall consist of an arrester between each line wire and ground, and a fuse in each line wire, the fuses protecting the arrester. The protector terminals shall be plainly marked to indicate "line," "instrument," and "ground."

b. The protector shall not be placed in the immediate vicinity of easily ignitable material or inflammable gases, or dust or flyings of combustible material.

c. Where the entire street circuit is run under ground, a protector shall not be required unless the circuit within the block is so placed as to be liable to accidental contact with electric light or power wires operating at a potential exceeding 250 volts.

6005. Grounding.

a. The ground conductor of the protector shall consist of not less than No. 18 copper, having $\frac{1}{32}$ in. rubber insulation, covered with a substantial braid. Where necessary, it shall be guarded from mechanical injury.

b. The ground conductor shall be run in as straight a line as possible to a permanent and effective ground. Where connection is made to a gas pipe, attachment shall be made between the meter and the street main. In every case the attachment shall be made as close to the earth as practicable.

A suitable ground may be obtained by connection to either a water pipe or a gas pipe, preferably to the former. A ground rod or pipe driven into permanently damp earth is acceptable, in the absence of a piping system.

c. The ground conductor shall be attached to the pipe by means of an approved bolted clamp to which the conductor is soldered or otherwise connected in an approved manner, or the pipe shall be tinned with rosin flux solder after which the conductor shall be wrapped around the pipe and thoroughly soldered to it.

d. Steam or hot water pipes shall not be employed as a ground for protectors.

2. The Signal Wiring Of A Modern Building Is An Important Element. The extensiveness and importance of the signaling system in any structure depends largely upon the type of building and the functions of the signaling system. The signaling system of a modern department store will usually include the following: intercommunicating telephone system, watchman call and fire alarm, auto-call system, telautograph, credit telephone, time-recording system, sprinkler alarm, elevator dispatching, and automobile call. The signaling system in a modern hospital will ordinarily comprise various nurse and doctor call systems; in a factory, automatic calling systems and time recording devices; in hotels and apartments

various program systems are used. Each building must be equipped to satisfy its specific needs.

3. Conductors Of Various Types Are Employed In Wiring For Signaling Systems. Among those which are used are: double-cotton-covered annunciator wire, duplex office wire, twisted telephone wire, rubber-insulated signal wire, weatherproof signal wire, and intercommunicating cables. The principal difference between the conductors of the various types is in their insulation; the conducting material is, practically always, copper. In the twisted telephone wire, duplex office wire, and intercommunicating cables, the individual coverings of the different component conductors are of different colors. Such a *color code* facilitates the connecting of the apparatus and eliminates the necessity of testing out, which operation consumes considerable time.

4. Double-cotton-covered Annunciator Wire Is Ordinarily Used For Simple Bell And Annunciator Wiring in residences and other unimportant structures. This wire (Fig. 411) is

FIG. 411.—Double-cotton-covered annunciator wire.

insulated with two winds (two layers) of cotton yarn, applied in opposite directions, saturated with a special wax compound and then highly polished on the outside. The wire is supplied on spools of 1 lb. or of 8 lb. capacity. The wire is manufactured with both plain copper and tinned-copper conductor. It can regularly be obtained with insulations of any one of the following colors: red, red and white, brown, brown and white, white, olive, yellow, yellow and white, blue, blue and white, green, green and white. Insulations of other colors can be supplied to special order. This wire is manufactured in both the single and twisted pair-conductor types of the following sizes, B. & S. gage: 22, 20, 18, 16, and 14.

5. Damp-proof, Office Signal Wire Should Be Used Where The Conductors Are Subject To Moisture. This wire (Fig.

412) has a triple cotton insulation. The two inner wraps are saturated with a black, weather-proofing compound. The outer braid is treated with a special wax, highly polished, so as not to collect dust. Damp-proof office wire can be obtained in coils of about 10 lb. or on spools of 5- or 10-lb. capacity. It is manufactured with its outer braid of any one of the fol-

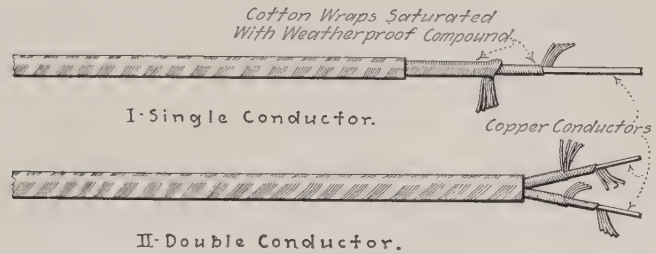


Fig. 412.—Damp-proof office wire.

lowing colors: red, red and white, blue, blue and white. Single- and duplex double-conductor, damp-proof, office wire can be obtained in the following sizes, B. & S. gage: 20, 18, 16, and 14.

6. Elevator Annunciator Cables Are Used For Connecting Elevator Cab Annunciators With The Corridor-push-button Leads. Since these cables (Fig. 413) are subjected to constant

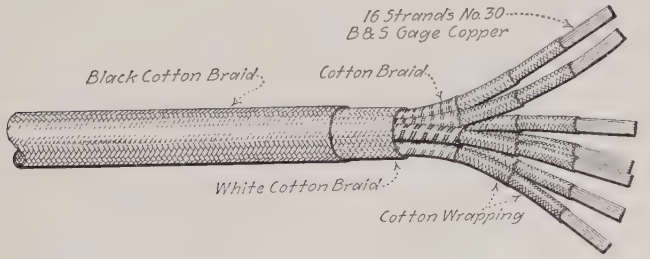


Fig. 413.—Elevator annunciator cable.

bending, they must be so designed as to have reasonable flexibility. For example, each conductor may be composed of 16 strands of No. 30 B. & S. gage, soft, untinned copper wire, with two reverse wrappings of cotton and one cotton braid. The outer braids of the individual conductors are of different colors, which facilitates tracing the various circuits.

The insulated conductors are then cabled together, with a steel supporting strand in the center of the bunch which provides the necessary tensile strength in the cable. The group of conductors is then covered with two cotton braids; the inner one is white and the outer one black. This cable is designed for use in dry places only; its covering is neither water- nor flameproof.

7. Office Annunciator Cable Is Employed For Interior Installations. It (Fig. 414) should be used only in perfectly

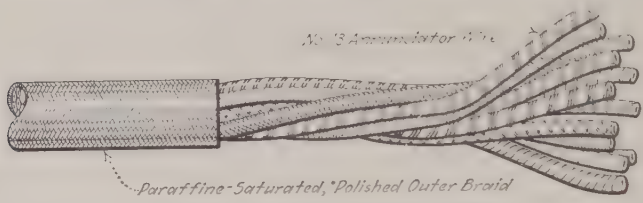


FIG. 414.—Office annunciator cable.

dry places, such as are usual in office buildings, hotels, and similar buildings. It is made up of various numbers of No. 18 annunciator wires, cabled singly or in pairs, and color coded. This cable is protected with a heavy outside braid which is thoroughly saturated in paraffin and polished. The cable can also be obtained with the outer braid saturated with a gray painted flameproofing compound.

8. Weatherproof Annunciator Cable Should Be Used Where Dampness And Moisture Are Present. This cable (Fig. 415)

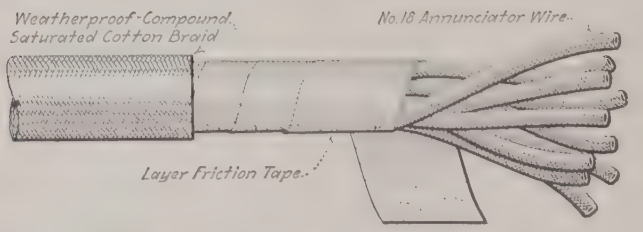


FIG. 415.—Weatherproof annunciator cable.

is similar to office annunciator cable. It is made up of annunciator wires which are, after cabling, saturated in a paraffin compound. The cable is then wrapped with friction rubber

tape, over which is served a stout cotton braid impregnated with a black weatherproof compound.

9. Rubber-insulated Annunciator Cable Is Frequently Used As A Substitute For Lead-sheathed Cable. It (Fig. 416) is often employed for intercommunicating-telephone, machine recorder and other interior cables. A number of No. 18 B. & S. gage annunciator wires are cabled together and covered with a seamless belt of rubber. A covering of stout cotton braid, which is saturated with weatherproof compound, protects the rubber insulation. A cable construction of this form is more effective in preventing the entrance of moisture than are any of the others previously described. It may often be economically employed for services in which lead-covered cable is

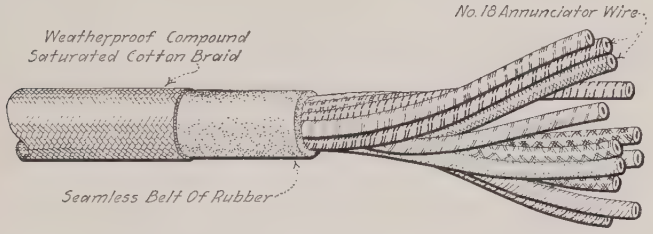


FIG. 416.—Rubber-insulated annunciator cable.

ordinarily used. A lead casing (Sec. 10) on a cable will absolutely prevent the entrance of moisture, but lead-encased cables are too expensive for many applications.

10. Lead-covered, Paper-insulated Telephone Cable Is Employed For Outdoor Aerial And Underground Installations, And In Important Interior Work, Particularly Where Dampness Exists. It consists of copper conductors (Fig. 417), insulated with paper, twisted into pairs, and enclosed in a lead sheath. In general, the cable which has single-paper-wrapped conductors is recommended, since its electrical and mechanical characteristics are perfectly satisfactory for most conditions and it costs less than does the cable with double-wrapped conductors. The sheath is made of pure lead, of lead-antimony or of lead-tin alloy. Either lead-antimony alloy or lead-tin alloy is satisfactory for aerial and underground cable, but the

lead-antimony is the cheaper and is more generally used. Pure lead cannot be recommended where the cable is subjected to vibration, but is often suitable for use within buildings.

11. Note.—The Conductor Capacities And Conductor Sizes Of Lead-covered, Paper-insulated Cable are as follows: The number of pairs of conductors range from 5 to 1,200. The size of the conductors varies from No. 13 to No. 24 A.W.G. The correct size of conductor, the number of pairs, and the type of cable which is to be used for any particular installation will be governed by the kind of service to which the cable is to be applied and also the location in which the cable is to be

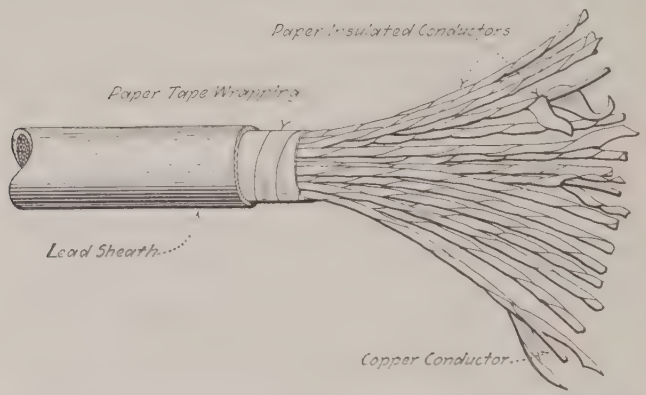


Fig. 417.—The construction of lead-covered paper-insulated telephone cable.

used. For long aerial or underground lines, No. 13 and 16 A.W.G. gage cables are employed. The number of pairs of conductors of these types can be obtained up to 75 and 150 pairs, respectively. Cables up to 300 pairs can be obtained in No. 19 A.W.G. gage conductors, up to 900 pairs in No. 22 A.W.G. gage conductors, and up to 1,200 pairs in No. 24 A.W.G. gage. Cables of these larger number of pairs of conductors are used only in underground construction.

12. The Advantages And Disadvantages Of Paper-insulated Cables are these: Paper-insulated cables are used for aerial and underground installations because their cost is lower than that of double-silk- and single-cotton-covered insulated cables. For interior work, however, and for terminating paper-insulated cable, double-silk- and single-cotton-covered insulated cable is preferred. Although cables of the latter type do, uninstalled, cost more than does paper-insulated cable, they

are better adapted for use in interior installations, and, installed, will cost less where much splicing and terminating is necessary. Intercommunicating telephone systems and extensive annunciator systems are typical cases for which silk- or cotton-covered cables are fitted. Another point to consider, in the average installation, is that the regular electrician who installs the lighting and power circuits also installs the signaling circuits. These workmen are not, usually, proficient paper-insulated cable splicers. As has been stated in a previous section, the splicing of paper-insulated cables requires one familiar with this work. Paper-insulated cables should, therefore, be used only when such workmen are available. See Secs. 31 to 36 for in rmation concerning the effective handling of cables.

13. Twisted Pair, Weatherproof, Telephone Wire For Inside Use (Fig. 418) is insulated with two or three braids of

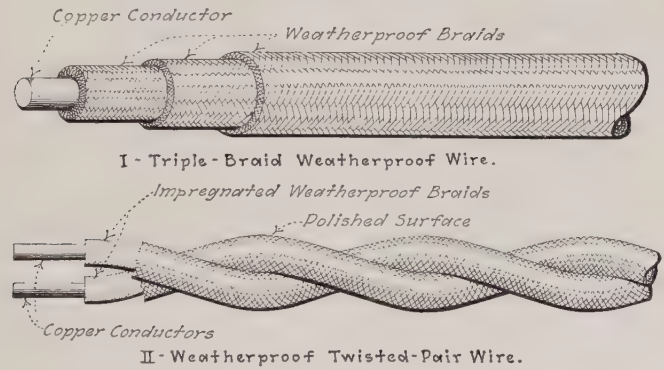


Fig. 418.—Illustrating triple-braid weatherproof wire and weatherproof twisted-pair telephone wire.

cotton yarn. The braids are thoroughly impregnated with a black, weatherproofing compound which is finished with a hard, smooth polish. The conductors are then twisted together into pairs. This wire can be obtained in the following sizes and braids: No. 14-3 Brd.; No. 16- and 18-2 Brd.

14. Railway Signal Wire Must Be Made To Conform With The American Railroad Association Signal Division Standard Specifications. Thorough insulation is of more importance in

railway than in ordinary signal installations because the safety of millions of passengers depends upon the reliability of the signals.

15. Note.—The Present American Railroad Association Signal Division Standard Specification For Rubber Insulation Has Been Developed By A Representative Committee Of Signal Engineers. They have developed a specification resulting from a study of the manufacture, inspection, and use of rubber insulated wire extending over a period of many years. The specification has undergone changes in this time and every change has improved the product.

16. Rubber Insulated Signal Wire For 660 Volts Or Less can be obtained with either single (Fig. 419) or double conductors. These conductors range in size from 0 to 18 A.W.G.

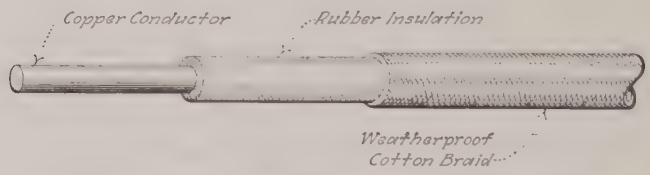


Fig. 419.—Rubber insulated signal wire for 660 volts or less.

The insulation on each conductor should consist of American Railway Association Signal Division Compound. A weatherproof cotton braid, $\frac{1}{32}$ in. thick, is placed over the insulation. The thickness of the rubber insulation over the conductor varies with its size: No. 0-2 inclusive, $\frac{1}{8}$ in.; No. 4–8 inclusive, $\frac{3}{32}$ in.; No. 9-14 inclusive, $\frac{5}{64}$ in.; No. 16–18 inclusive, $\frac{4}{46}$ inch.

17. Telephone Cable For Interior Construction Ordinarily Has The Conductors Insulated With Two Coverings Of Silk And One Of Cotton. These cables (Fig. 420) are usually made with their conductors color coded; that is, the insulations on the different conductors are of different colors. This eliminates much testing in connecting the cable. Extra pairs are placed in all cables containing conductors smaller than No. 16 to replace any pairs which may become defective during manufacture. In the majority of cables, all or a portion of

the extra pairs will be found good; they may be used for additional circuits.

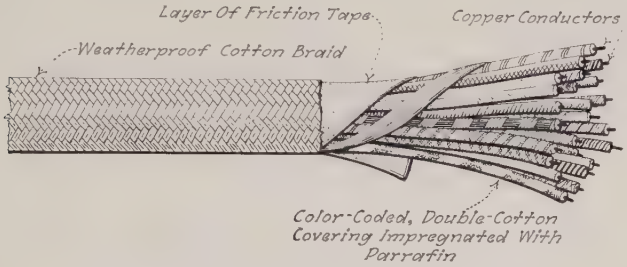


FIG. 420.—Intercommunicating telephone cable.

18. Metal Staples Are Used To Support Signal Wires On Beams And Joists. All conductors should be run parallel

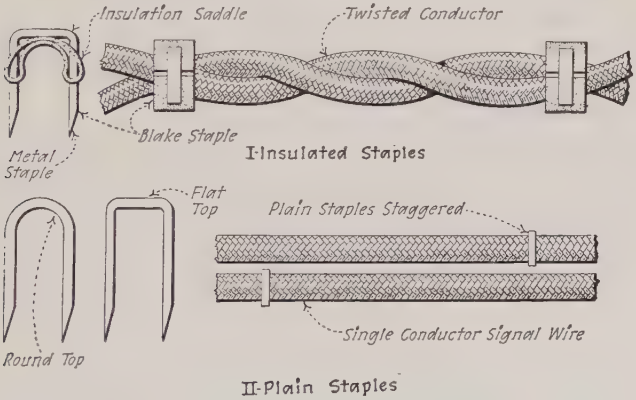


FIG. 421.—Plain and insulated staples and the method of their use.

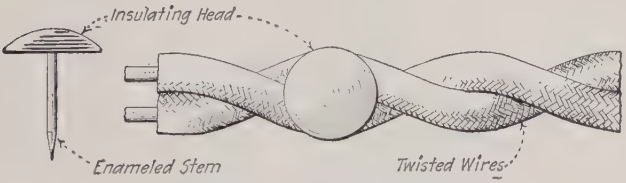


FIG. 422.—The Eureka fiber insulator.

with each other. If ordinary staples (Figs. 421 and 422) are used, only one conductor should be placed under each staple

and the staples must be staggered sufficiently far apart so that they will not touch each other. If insulated staples are used (Figs. 421 and 423), two or more conductors may be placed under one staple. But care should be taken in driving the staples not to break the insulating saddle, otherwise short-circuiting of the conductors is likely to result.

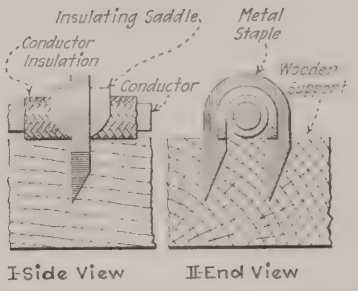


Fig. 423.—An insulated staple of one type.

19. Note.—Flat-top, Metal Staples Are Preferable To Round-top Staples (Fig. 421-*II*). It is more difficult to drive the round-top staples straight than it is the flat-top staples. Also, staples which have a coating of zinc are preferable to those which are copper plated.

20. Insulated Nails Are Used Extensively For Supporting Twisted Pair Conductors. These nails (Fig. 424) have a metal stem and a head of insulating material. They can be obtained

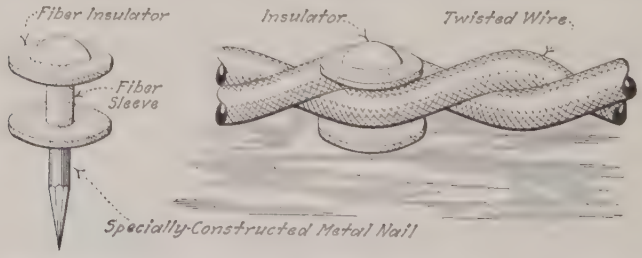


Fig. 424.—Method of supporting twisted conductors with insulated nails.

with heads of the following colors: light-oak, dark-oak, dark-green, and black. They are made with shanks ½, ⅝, and ⅞ in. long. When supporting conductors with these nails, care should be exercised not to drive the nails through the

conductors, causing a break in the wire. Another form of twisted pair support is the fiber insulator shown in Fig. 422.

21. Cleats Provide A Satisfactory Means Of Supporting Twisted Pair Conductors In Exposed Places. They are particularly desirable where the conductors must be supported on plastered surfaces, as they can be fastened with either nails

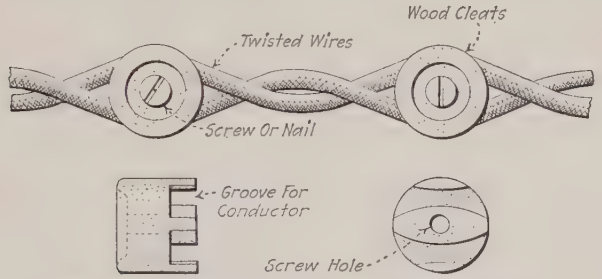


Fig. 425.—Wood cleat and its application for supporting twisted conductors.

or screws (Fig. 425). They are made in various shapes and sizes, of compressed, impregnated wood, and of hard fiber.

22. Bridle Rings Are Used To Support A Group Of Signal Or Telephone Conductors. These rings (Fig. 426) are employed extensively where a "bunch" of telephone conductors is carried to a terminal box. They can be obtained in

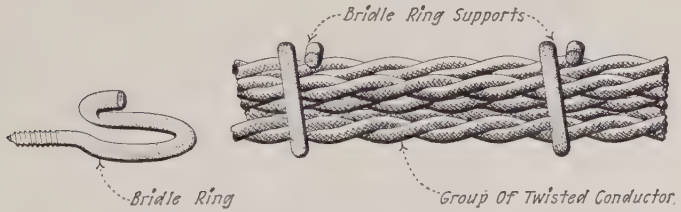


Fig. 426.—A bridle ring and its use.

four sizes, with the following eye diameters, $\frac{5}{8}$, $1\frac{1}{4}$, $1\frac{5}{8}$, and 3 in. They can be obtained with either a galvanized or a gray enamel finish.

23. Signal Circuits Which Are Likely To Be Struck By Lightning, Or To Contact With Light And Power Wires Should Be Provided With A Protector. In general, all outside aerial

circuits should thus be provided with protectors (Fig. 427), but for circuits which are wholly under ground or wholly inside, protectors are not ordinarily considered necessary. The type of protector (Fig. 428) which is used extensively on telephone

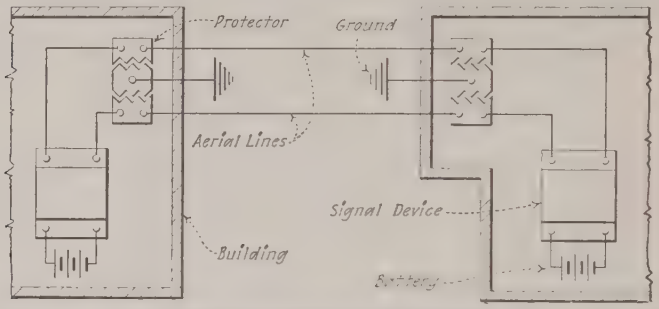


Fig. 427.—Schematic diagram showing the arrangement of the protectors on an aerial signal line.

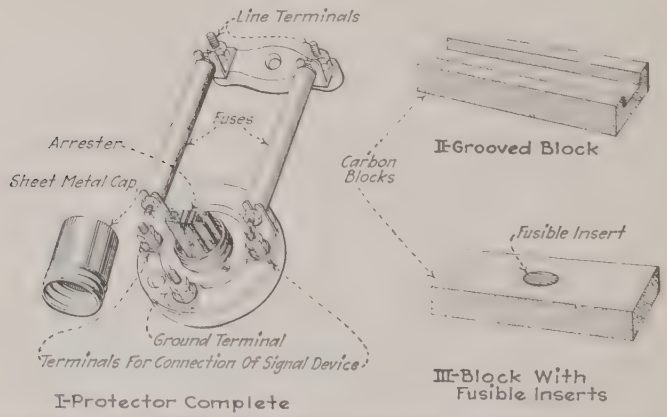


Fig. 428.—The Western Electric Co. telephone protector. The fuses are employed only where the signal circuit is exposed to light or power wires. Where there is no possibility of the signal circuit crossing with these higher-tension wires, only that part of the protector which is supported on the circular base is required.

(Fig. 429), fire-alarm, and similar circuits, consists essentially of a lightning arrester and two fuses. The arrester comprises four carbon blocks, two plain grooved blocks, *II*, and two blocks containing a fusible insert, *III*. The two inner "carbons," which are those which contain the fuse metal, are connected

to the ground wire and insulated from the two outer "carbons," which are connected to the circuit which is to be protected. The insulation between these carbon blocks is a thin perforated mica sheet.

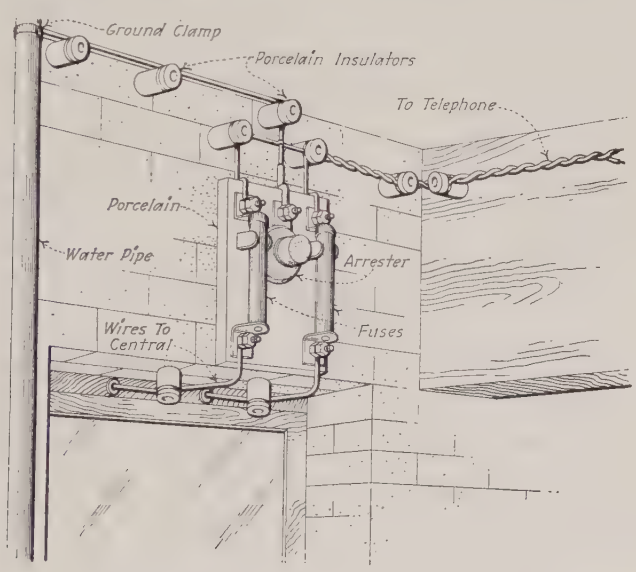


FIG. 429.—A Western Electric Co. protector installed.

24. EXPLANATION.—Ordinary lightning discharges will cause an arc across the air gap (which is provided by the perforation in the mica sheet) between the carbon blocks. But it will not ordinarily heat the blocks sufficiently to melt the fusible inserts. Should the circuit become crossed with an electric light or power circuit, however, the discharges across the gap will be of sufficient duration to heat the carbon blocks enough to melt the fusible inserts. This causes the space between the outer and inner blocks to fill with the molten metal, thereby establishing a connection between one, or both, line wires and ground. This ground connection will remain until the "carbons" are "cleaned;" that is until the projecting metal is scraped off.

25. The Installation Of A Simple Signaling System Does Not Require Any Great Degree Of Skill. By a simple signaling system is meant one that consists only of one to several bells, batteries, and push buttons. But it is obvious that the installation of an extensive signaling system, such as an elevator

annunciator system, or an automatic paging system, requires one who is skilled and thoroughly familiar with such systems.

26. Various Methods Can Be Employed For The Installation Of Signal Wiring In Old Buildings. They may be grouped under two headings: (1) *those used for exposed wiring;* (2) *those used for concealed wiring.* These methods will be explained in the following sections.

27. The Installation Of Exposed Signal Wires requires little explanation. They should be installed in a neat, workmanlike

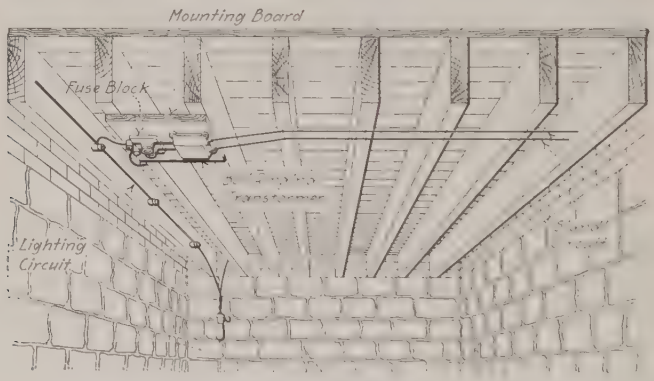


Fig. 430.—Installation of a bell-ringing transformer.

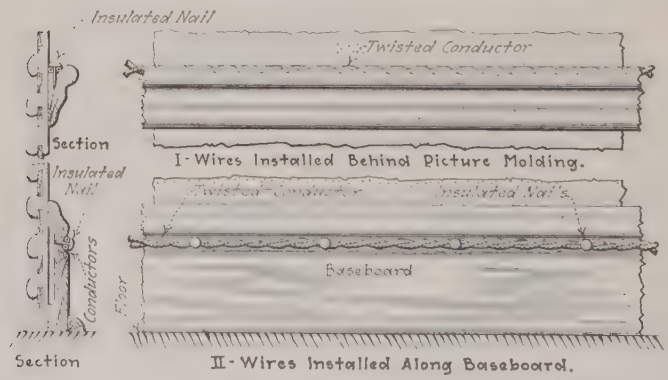


Fig. 431.—Illustrating the method of supporting signal wires along picture molding and baseboard.

manner. Various types of nails and cleats are manufactured to support these conductors, as explained in Sec. 20. In

unfinished basements or cellars, the wires can be fastened directly to the joists (Fig. 430). In rooms and offices, the baseboard or picture molding (Fig. 431) often provides a convenient location in which to support the wires. The picture molding usually permits semiconcealment of the conductors.

28. When It Is Desirable To Conceal Signal Wires In An Old Building, they may be fished somewhat as is done in con-

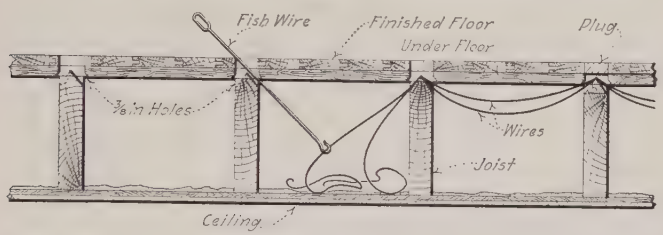


Fig. 432.—Method of running signal wires concealed under a finished double floor.

cealed light wiring. Figure 432 illustrates a procedure by which signal wires may be concealed under double floors: First, locate the joists; then, with a $\frac{5}{8}$-in. bit, bore a hole through the top flooring and into each joist straight down. Bore two smaller holes, say $\frac{3}{8}$ in., so as to straddle the joists

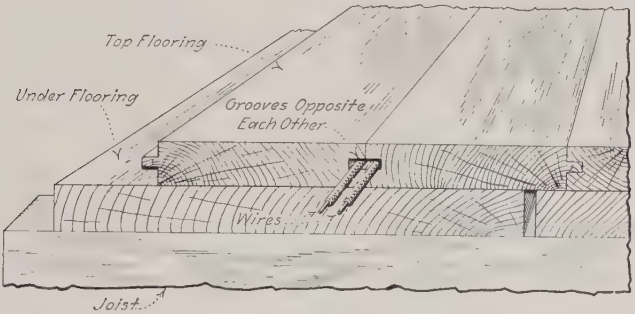


Fig. 433.—Method for running signal wiring. By placing two grooved sides of matched flooring together, an excellent runway for such conductors is provided.

as shown. The annunciator wires can then be fished from one hole to the other. After the wire has been fished, the holes can be plugged with corks or wooden plugs.

29. Note.—Another Method Of Concealing Signal Wiring In Matched Flooring is shown in Fig. 433. The wires must be installed while the carpenter is laying the flooring. Have the carpenter reverse the last two floor boards, placing the two grooves together. A small runway results which is suitable for the concealing of bell or annunciator wires. A hole bored through the wall opposite each double groove renders it possible to fish through partitions.

30. Conduit Is Used For All Modern, Important, Signal-wiring Installations. These conduits are the same kind and are installed in the same manner as those which are used for

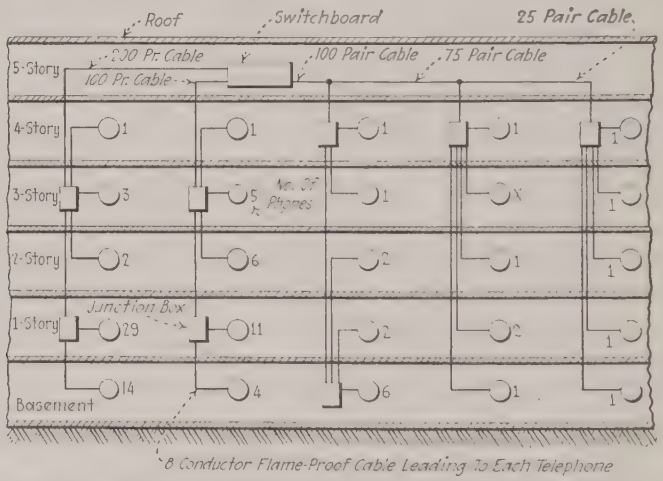


Fig. 434.—Riser diagram of a typical cable plan for a credit telephone system in a modern department store.

lighting circuits (see the author's "Conduit Wiring"). The iron or steel fittings, boxes, and cabinets are similar to those which are employed in light wiring. The conduits are installed as a complete system before any wires are drawn into them. Rubber-covered, twisted-pair copper wires are most frequently used in conduit systems. Figure 434 shows riser and floor plans of typical signal-wiring installations. See also the author's "Conduit Wiring" for descriptions of installations in large buildings.

31. When Installing Paper-insulated Telephone Cable, It Is Important Not To Kink It Or To Permit Moisture To Enter The Core. The conductors are insulated only by paper,

which is useless if moist, and is of value only because it encloses dry air. As soon as the lead sheath has been removed from a cable for splicing or terminating, the paper insulation absorbs moisture from the air and from the hands. It is, therefore, important that the core be exposed as little as possible after the lead sheathing has been removed, and that the exposed end be boiled out with paraffin (which removes the moisture), as soon as possible.

32. Cable Is Used Where A Large Number Of Conductors Is Required. Among the more frequent applications for the use of cable are: (1) *intercommunicating telephone systems;* (2) *automatic calling systems;* (3) *extensive annunciator systems such as nurses call systems, hotel and apartment annunciators, elevator annunciators, and the like.* A riser plan of a typical cable system for a credit telephone system is shown in Fig. 434. Wherever cable is employed, terminal strips and cabinets are necessary. These are described in following sections.

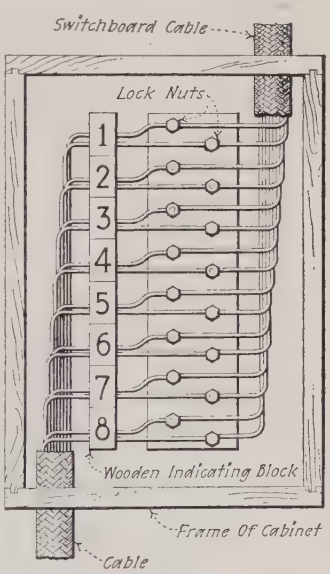


Fig. 435.—Illustration of cross connecting cable terminal block.

33. Cable Terminal Strips Facilitate The Connecting Of The Cable Conductors To Wires Outside Of The Cable. They are also used where a junction is to be formed between two or more cables (Fig. 435), which is frequently necessary in intercommunicating telephone systems. Another frequent use for terminal strips is where an outside lead-covered cable is to be connected to an interior cable, or whenever a branch is taken from a main cable. These blocks are usually mounted in a metal (or wooden) cabinet. They should be located in a dry, accessible place, preferably near centers of distribution. When it is necessary to fasten more than one conductor to the

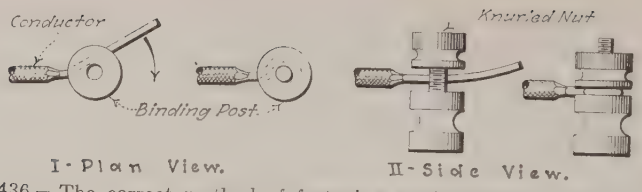


Fig. 436.—The correct method of fastening a wire under a binding post.

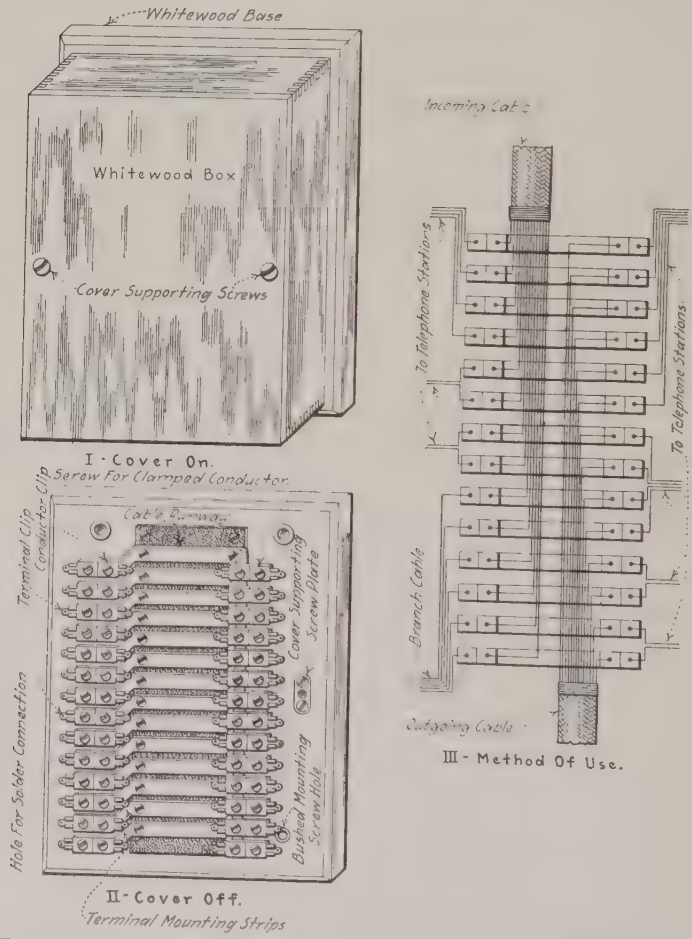


Fig. 437.—The Couch telephone junction box. The feature of this box is that either a screw or soldered connection of the conductors can be made to its terminals.

same binding post, the wires should be separated with washers. This prevents the wires from cutting each other. Figure 436 shows the proper method of fastening a wire under a binding post.

34. Note.—Terminal Strips Are Made In Two Types: The Solder Type And The Screw Type. A combination solder- and screw-

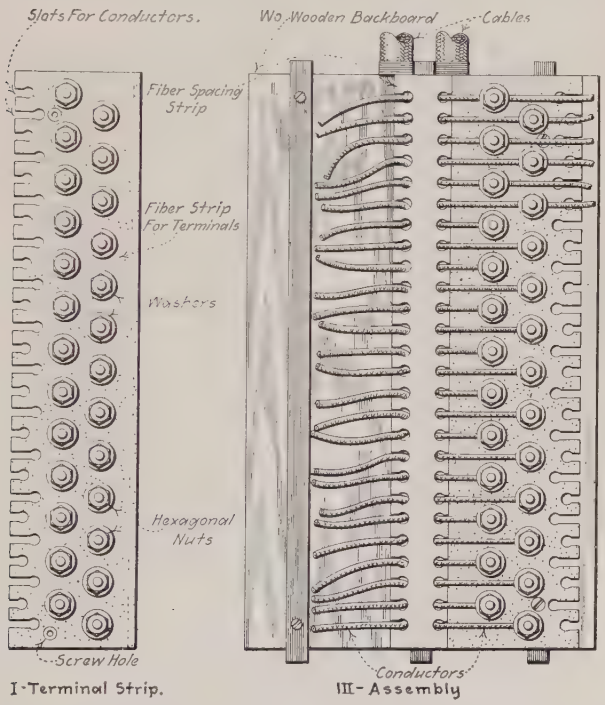


Fig. 438.—Illustrating an Auth telephone terminal strip. One of the advantages of this type of connecting strip is elimination of the necessity of forming and lacing of the cable before connecting to the strip.

type terminal strip is illustrated in Fig. 437. With a terminal strip of this type, the workman can make either a screw or soldered connection, whichever he may prefer. Even if the connection is soldered, it is not necessary to unsolder for a test; merely loosen the corresponding screw and slip the corresponding terminal clip from under it, with the wire attached. Other types of terminal strips are shown in Figs. 439 and 440.

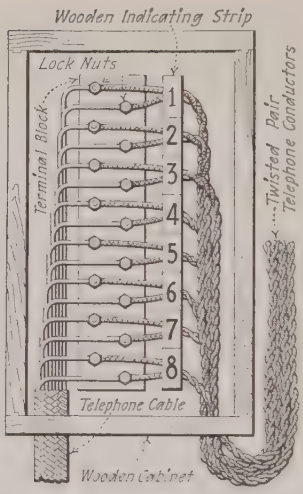


Fig. 439.—Terminal block used to connect a number of telephone circuits to a cable.

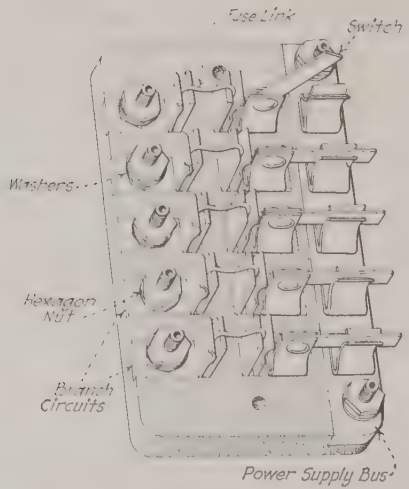


Fig. 440.—Fused battery strip which is designed to protect the branch circuits from batteries or motor generators which are used to furnish power for signaling.

35. Cables Should, Ordinarily, Be Formed Before They Are Connected To Terminal Strips. The forming (Figs. 441, 442, 443, 444, 445 and 446), consists in fanning out the

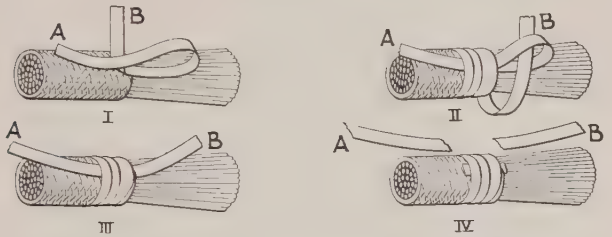


FIG. 441.—"Butting," or forming a "butt" on a cable end.

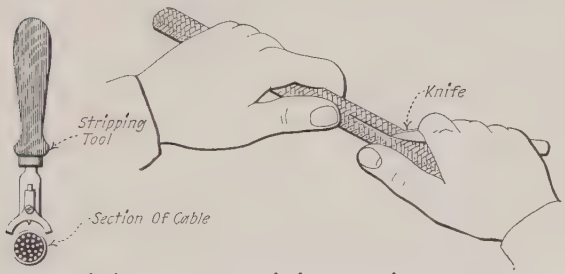


FIG. 442.—Stripping the outer insulation from a cable.

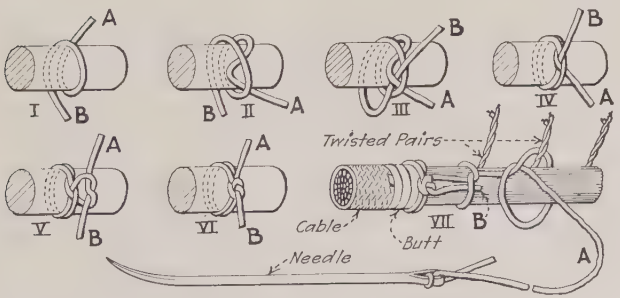


FIG. 443.—Tying the "butt" knot on a braided-insulation cable.

cable so that the wires which constitute the individual circuits will be arranged systematically with reference to the

terminals on the terminal strip. The braiding which covers the core or conductors of the cable is first removed, as shown Fig. 442. This can be accomplished with a pocketknife or the special cable-stripping and butt-cutting tool. In using

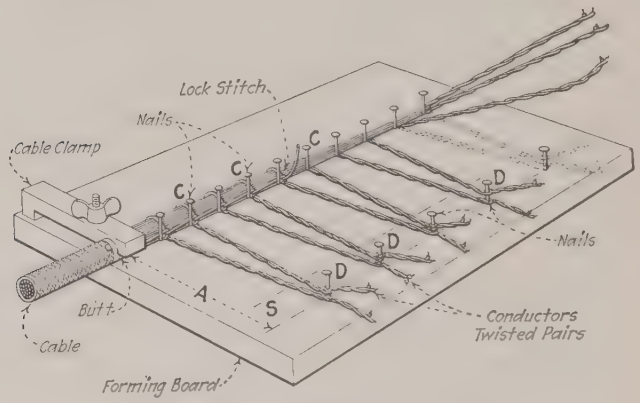


Fig. 444.—"Forming" a cable end.

this special tool, the cutting blade can be set so that it will cut only to the depth of the braiding. After the braiding has been removed the proper distance, a butt is formed over

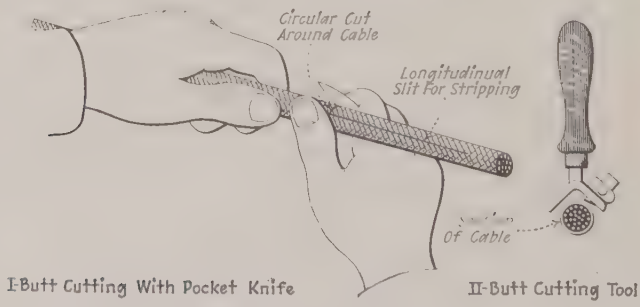
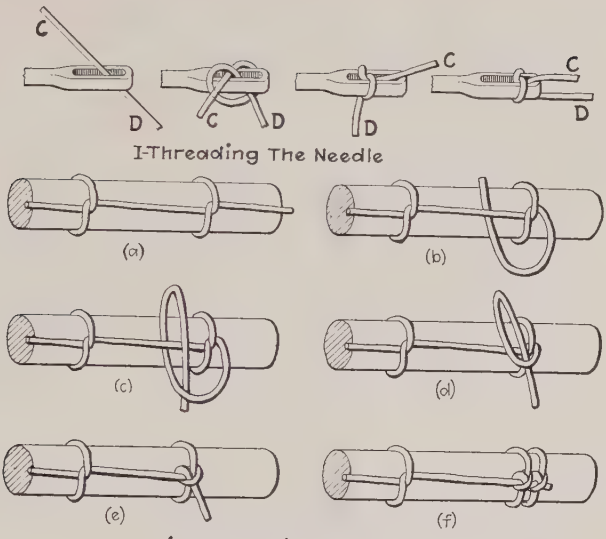


Fig. 445.—Cutting a "butt" on a braided-insulation cable.

the end of the braiding as shown in Fig. 441. A forming board (Fig. 444), is then provided, which has nails located at points corresponding to the terminals on the connecting block. A wooden clamp is arranged to clamp the cable to the forming



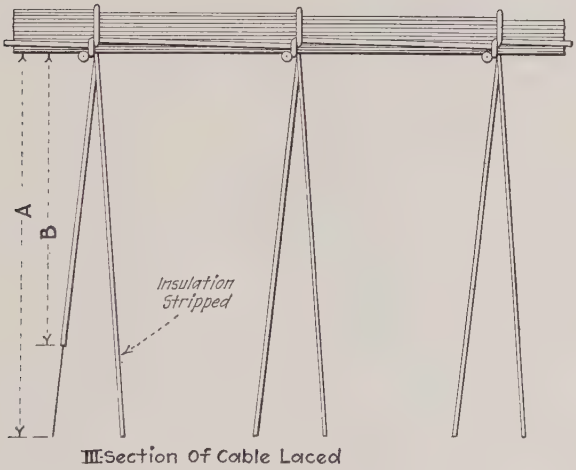


FIG. 446.—Lacing a cable.

board during the process of forming. After the conductors are fanned out as required (Fig. 447), the cable is laced (Figs. 443 and 446).

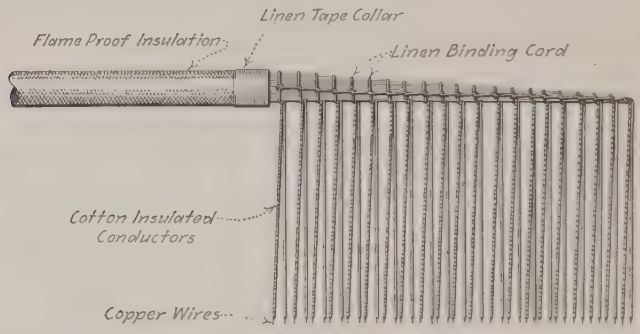


FIG. 447.—Showing cable fanned out ready for connection to terminal strip.

36. Cable Splicing is a trade in itself. It requires one skilled in the trade to make a satisfactory splice. This is partic-

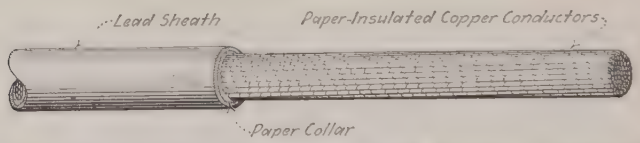


FIG. 448.—Paper-insulated-telephone cable with lead sheath stripped off in preparation for splicing.

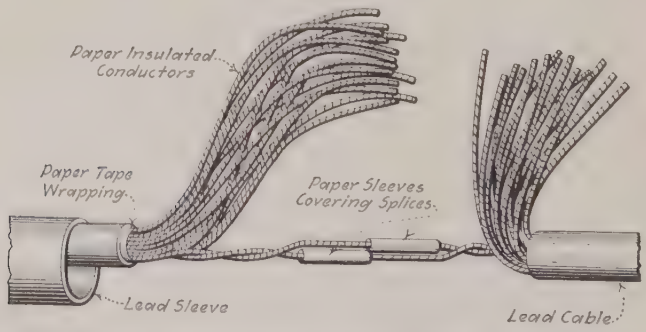


FIG. 449.—Showing the beginning of a cable splice. Note the lead sleeve which is slipped over one of the cable ends.

ularly true in splicing lead-covered cables which consist of a large number of pairs of conductors. Some of the important

points to consider in the process of the splicing are: the prevention of moisture from entering the cable during the splicing and after the splice has been completed; arranging the joints so that they are uniformly distributed throughout the entire length of the splice; sealing the splice to prevent moisture

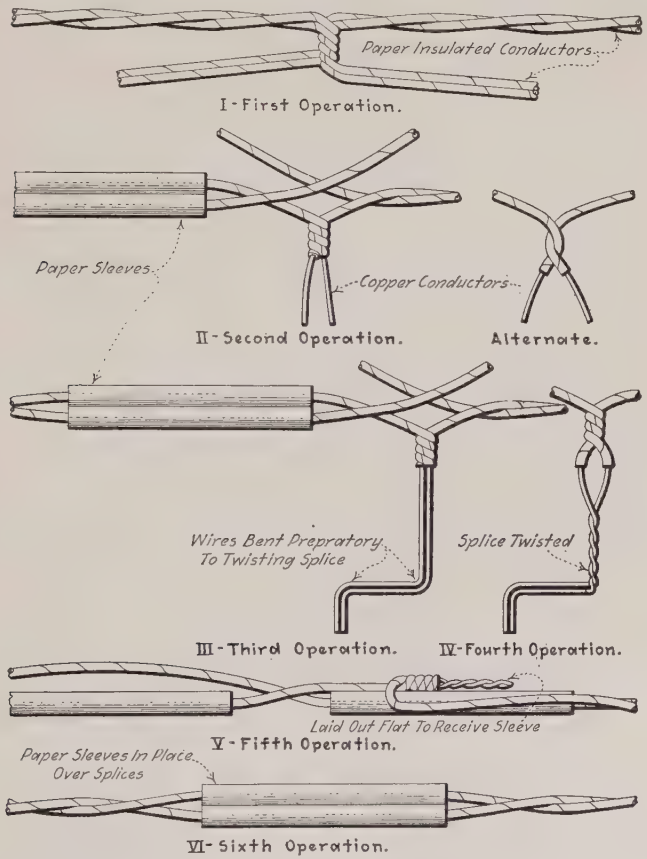


FIG. 450.—Showing the progressive steps in making a joint in a "straight splice" cable splice.

from entering. A brief description of the procedure in making a cable splice is given in the following note.

37. NOTE.—THE PROCEDURE IN MAKING A CABLE SPLICE is as follows: After the cable end has been cut off square, with a hacksaw, the lead

sheath should be cut away from the ends which are to be spliced together. About 2 ft. from each end will be necessary, as shown in Fig. 448. The wires should then be bound tightly together, where they emerge from the lead sheath, with cotton twine or wicking. The ends of the cable are then dipped in hot paraffin, which must be heated to a temperature above 212°F. and should remain immersed in the paraffin until all bubbling ceases. A lead sleeve (Fig. 449) is then slipped over one of the cable ends, of such dimensions that it will slip over the completed splice.

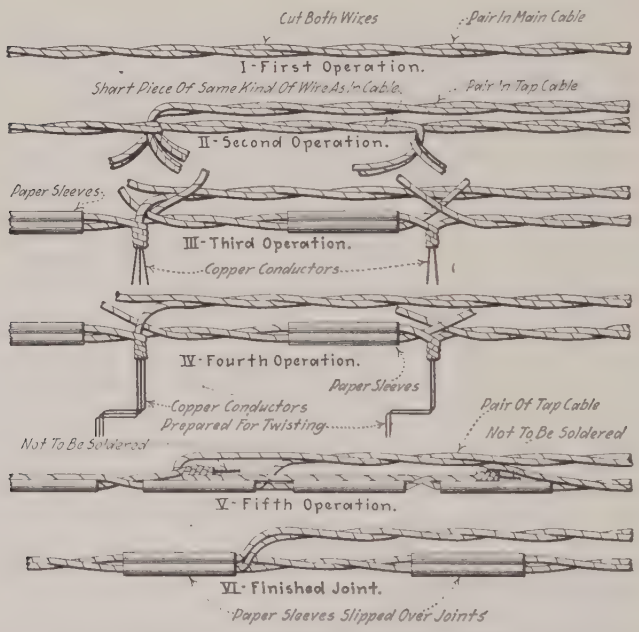


Fig. 451.—Progressive steps in making a joint in a "Y"-splice, cable splice.

The conductors are now ready for connecting. A paper sleeve is first slipped over each conductor of a pair to be connected together. The details of connecting the pairs together are shown in Figs. 450 and 451. After the two conductors have been connected together, the paper sleeve is slipped over the splice. It will be noted in the illustration that a portion of the insulation is included in the twisted connection, which is merely done to prevent the paper covering from sliding away from the joist as the paper sleeve is being slipped over it. All of the conductors are connected in a similar manner, uniformly distributing the connections along the length of the splice.

38. The Finished Splice Is Completely Sealed To Prevent The Entrance Of Moisture. Hot paraffin is first poured over the completed joints from a ladle. A pan is placed beneath the splice to catch the surplus paraffin which runs off the splice as the paraffin is applied with the ladle. This *boiling out* process should continue until all of the moisture has been

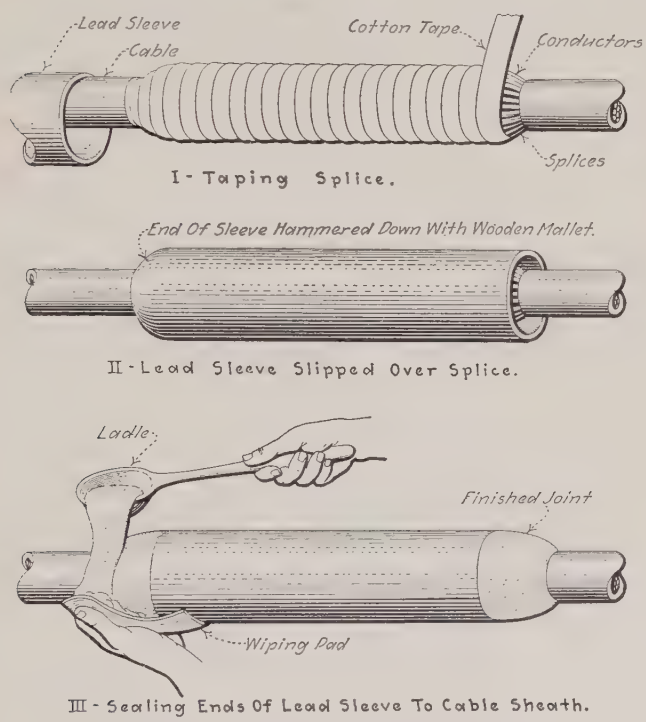


FIG. 452.—Finishing steps in splicing a cable.

driven out of the splice, which is indicated by the absence of bubbles. The splice should then be given a thorough wrapping of muslin tape as shown in Fig. 452-*II*. After the muslin has been applied, the splice should again be boiled out with hot paraffin, after which the lead sleeve should be immediately drawn over the splice as shown in Fig. 452-*II*. The lead sleeve

is formed down into close contact with the cable sheath, at each end, and a wiped joint is made over each end, as shown in Fig. 452-*III*. A completed pot-head splice is shown in Fig. 453.

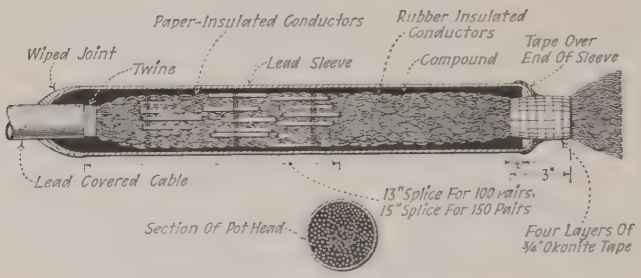


Fig. 453.—Section through a completed pot-head splice.

39. The Electrical Energy To Operate Signaling Systems Is Obtained From Various Sources. The type of signaling system determines, to a large extent, the most desirable source of energy supply. The energy is obtained either from batteries, a motor-generator set, a low-voltage transformer, or it may, for certain applications, be taken direct from a light or power circuit. These various sources of energy will be discussed in the following sections.

40. Batteries Are Used Extensively For Furnishing Energy To Signaling Systems. There are many types of batteries manufactured, and it is important that the correct type of battery be used. The batteries may be grouped under two general classes: (1) *those used on open-circuit signaling systems;* (2) *those used on closed-circuit systems.* Batteries designed for closed-circuit systems will usually operate open-circuit systems, but those designed for open-circuit systems will not give satisfactory service on closed-circuit systems. The various types of batteries used on such systems are described in the following sections.

41. Note.—The Meaning Of Open-circuit And Closed-circuit Signaling Systems is: An open-circuit signaling system is one in which the current flows through the circuit only when the signal is being sent over the circuit. A closed-circuit signaling system is one in which the

circuit has a current flowing continuously through it except when opening the circuit causes signals to be sent over it. The closed-circuit system is used extensively on fire-alarm and burglar-alarm systems. From the foregoing it is evident that a closed-circuit system requires a battery which is capable of delivering a continuous current flow, while an open-circuit system requires only intermittent flows of current.

42. Gravity And Storage Batteries Are Used For Closed-circuit Work. The gravity cell (Fig. 454) consists of a copper and a zinc element. The copper element is placed in the

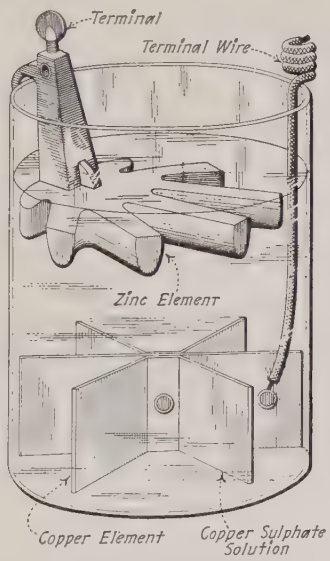


Fig. 454.—A crowfoot gravity cell.

bottom of the cell and is covered with copper-sulphate crystals. The zinc element is suspended from the side of the glass jar near the top by means of a cast-on lug. The glass jar is filled with water. The cell is then short circuited for about 24 hr., during which time zinc sulphate is formed around the zinc element and copper sulphate around the copper element. These two solutions remain separated by gravity, hence the name of the battery. To prevent evaporation, the top of the solution is covered with a layer of mineral or paraffin oil.

43. The Storage Batteries (Fig. 455) which are used for signaling systems are practically the same as those which are used for automotive work, with the exception that they are usually of the glass-jar type and the plates are larger and thicker and fewer in number. Otherwise the signal-system storage battery is identical with the one in everyday use.

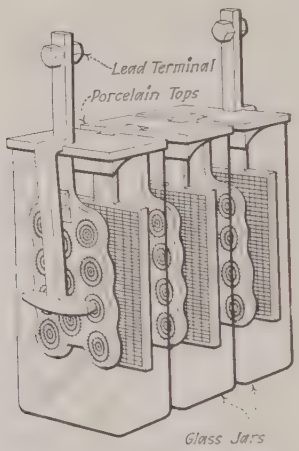


FIG. 455.—Storage cell of a type which is extensively on signaling circuits.

44. NOTE.—BOTH THE GRAVITY AND THE STORAGE BATTERY ARE CAPABLE OF DELIVERING A CONSTANT FLOW OF CURRENT for long periods of time without the detrimental effects which are produced in other batteries when they are called upon to furnish such closed-circuit service.

45. NOTE.—THE EDISON OR ALKALINE TYPE OF STORAGE BATTERY IS ALSO USED SUCCESSFULLY ON CLOSED-CIRCUIT SIGNALING SYSTEMS. These batteries (Fig. 456) are usually of the iron-nickel element type; their electrolyte is a dilute caustic-potash solution. The features of a cell of this type are its lighter weight, as compared with the lead battery, and its ability to withstand abuse successfully. Edison storage cells are used extensively for the propulsion of electric vehicles, and in railway block signaling and electric train lighting.

46. Batteries For Open-circuit Work are of numerous types. Those employed most frequently are the dry-cell, the so-called sal ammoniac "wet cell," and the Edison primary battery. The dry cell (Fig. 457) and the wet cell (Fig. 458)

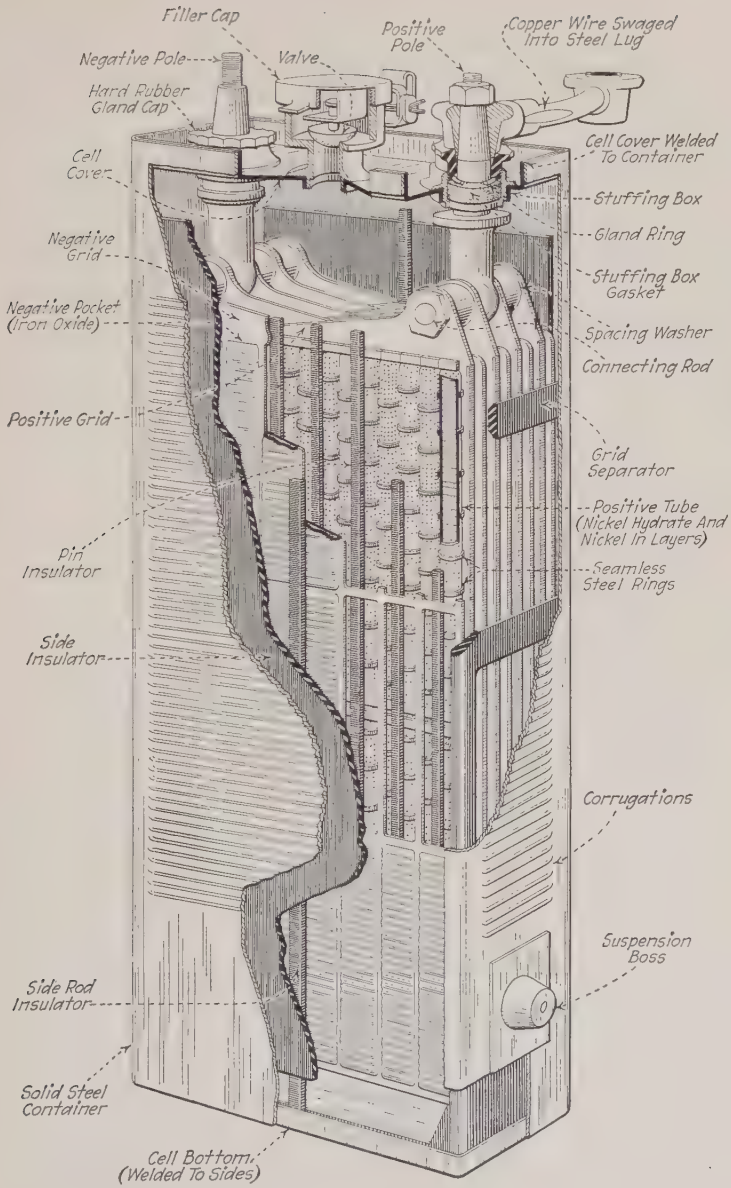


FIG. 456.—Illustrating an Edison alkaline battery.

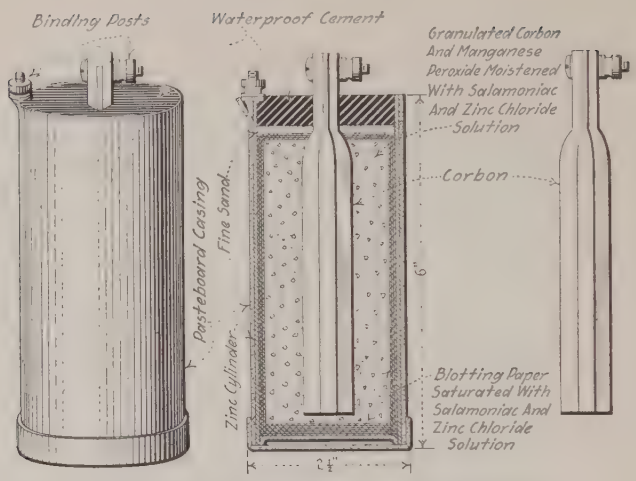


FIG. 457.—A dry cell and its interior construction.

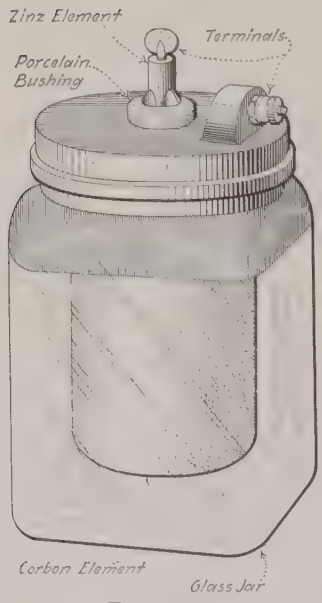


FIG. 458.

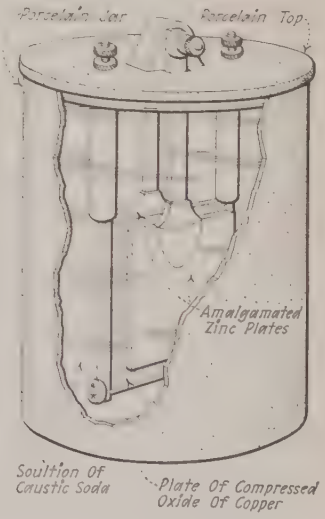


FIG. 459.

FIG. 458.—Illustrating the carbon-zinc wet battery. It consists of a carbon and a zinc element. The solution is of ammonium-chloride (better known as sal amoniac) and water.

FIG. 459.—The Edison primary battery.

are used extensively on small signaling systems (such as call-bell circuits in the home), and for other similar applications where only a small intermittent current is required. Where the system is large and considerable current is necessary, the Edison primary battery (Fig. 459) is employed. This type of battery can be obtained in capacities of from 200 to 500 amp. hr.

47. Note.—Low-voltage Transformers Are Superseding Open-circuit Cells where an alternating-current supply is available and where the signaling system will operate on alternating current. These transformers are discussed in Sec. 49.

48. Motor-generator Sets are frequently used as the energy source for signaling systems. They are employed where it is

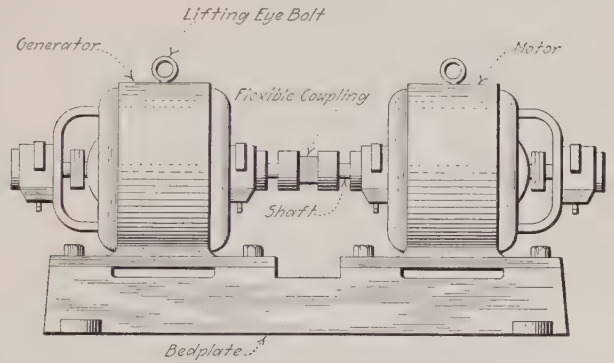


Fig. 460.—Motor generator set used for a signaling system.

desirable to obtain a low-voltage, direct current from an alternating-current lighting or power circuit. They are also utilized to convert direct-current lighting and power circuit voltages to lower voltages which are suitable for signaling purposes. Where a pulsating current (or one of a different frequency) is desired, such as is used extensively for ringing purposes on telephone systems, the motor generator is used. Figure 460 shows a motor-generator set designed for signaling system service.

49. Low-voltage Transformers Are used where a low voltage is desired from an alternating-current lighting or power circuit. A type of transformer used extensively for annunciator and call-bell systems is shown in Fig. 404. These trans-

formers are usually designed to operate on 110 volts on the primary side and impress about 8 volts on their secondary side. In most cases the exciting current is so small that it is insufficient to cause the ordinary watthour meter to register. They are very economical and reliable.

50. Dry Batteries Should Be Mounted Vertically. Figure 461 shows a convenient support for such a battery. Occasionally dry cells are mounted in a horizontal position. In this position, the wax is often melted out, particularly where they are located in warm places. If placed in a vertical position, although the wax does soften it will not flow out of the cell.

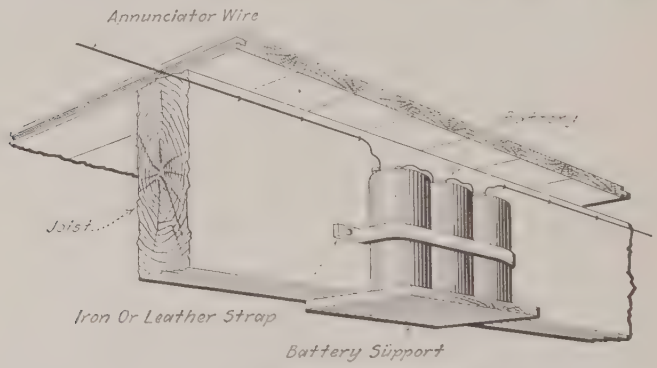


FIG. 461.—A neat and simple battery support.

When the sealing wax has melted out of a cell, the electrolyte, which is in the form of a paste, soon dries out, shortening the life of the cell. Wet cells should be mounted in a similar manner.

51. NOTE.—BATTERY SETS OF VARIOUS TYPES ARE MANUFACTURED. Figure 401 (Div. 15) shows one type of battery set which permits the replacement of the dry cells without disconnecting any wires. The dry cells which are employed are manufactured with a suitable threaded cap which screws into the supporting strip and also serves as one of the connections for the dry cell. A fused battery strip is shown in Fig. 440.

52. In Installing A Bell-ringing Transformer, it should be fused. Figure 430 shows a typical bell-ringing transformer installation. The transformer is connected, through suitable fuses, to a lighting circuit. A transformer will operate only on alternating current. Should the transformer be connected

to a direct-current circuit, its primary winding will be burned out, unless the fuse which protects the direct-current circuit is ruptured first.

53. Storage Batteries Should Be Installed In A Cool, Dry, Well-ventilated Room. A battery rack used for fire- and police-signal systems is shown in Fig. 462. It is standard practice in fire-alarm and police-call signaling to provide a

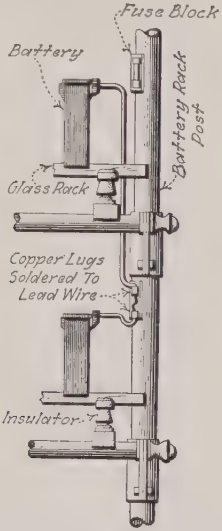


FIG. 462.—Illustrating a battery rack used to support the batteries of a fire-alarm and police-call system.

duplicate set of storage batteries, so that while one set is operating the system, the other set is *in reserve* or *on charge*.

54. Storage Battery Power Systems For Signaling Systems Usually Include Two Sets Of Storage Batteries—A Motor-generator Set And A Control Panel. Figure 463 illustrates a complete system. The control panel is equipped with the necessary switches to control the motor and generator. A rheostat in the generator field circuit regulates the rate of charge for the battery. A voltmeter and an ammeter in the generator circuit indicates the voltage and current, respectively, of the charging circuit. Fuses and a cutout relay protect the batteries and the motor-generator set against overloads or short circuits.

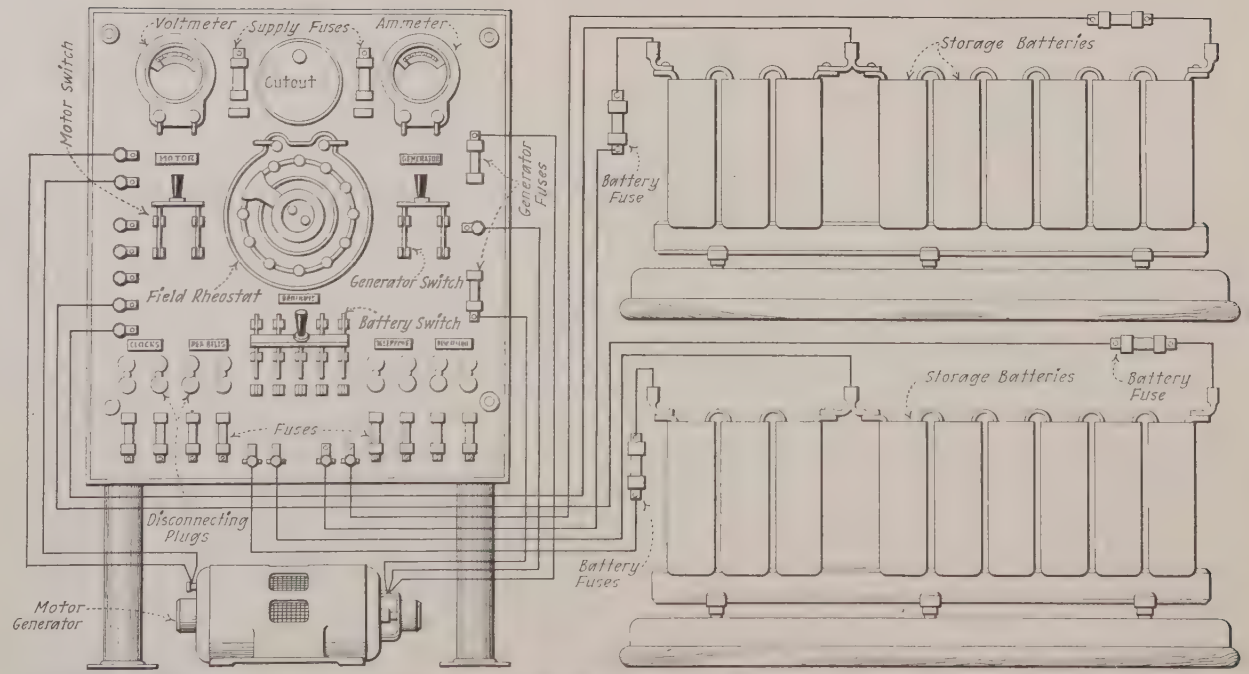


FIG. 463.—Illustrating a complete signaling power system. A motor-generator furnishes the power for charging the storage batteries. A switchboard controls the charging current. Two sets of storage batteries are provided, one is on charge or held in reserve while the other is in service. (HOLTZER-CABOT ELECTRIC CO.)

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